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DISCOVERY

A MONTHLY POPULAR JOURNAL OF KNOWLEDGE

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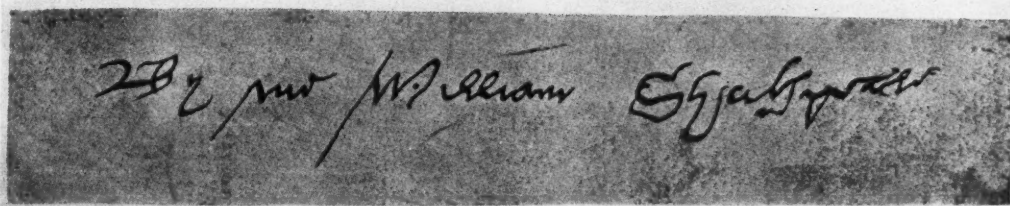
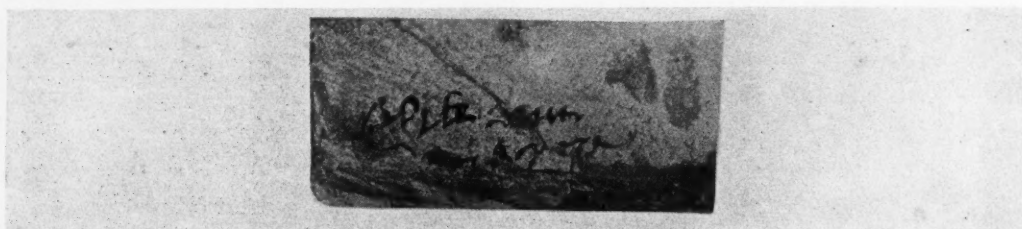
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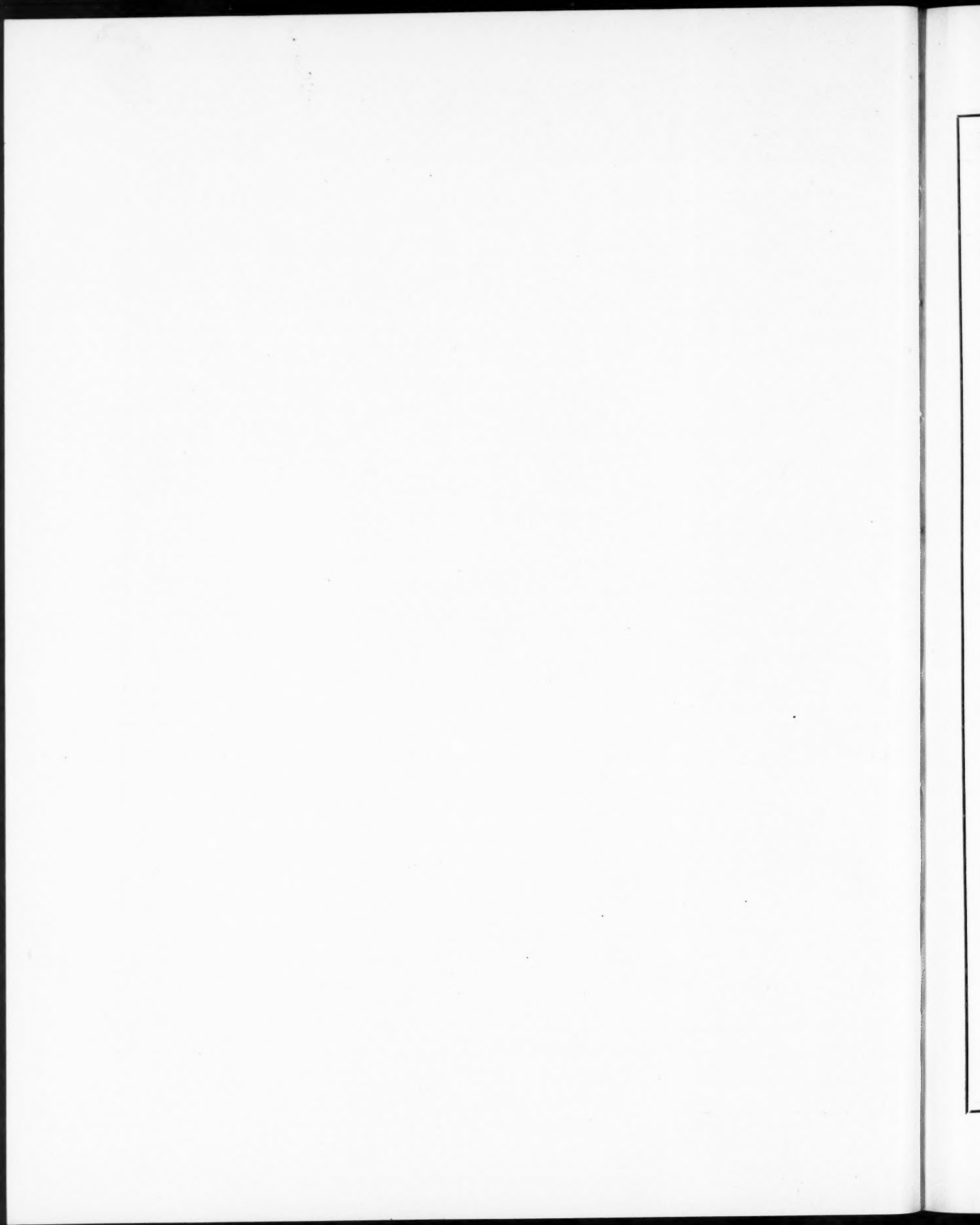
SHAKESPEARE'S SIGNATURES TO HIS WILL

From "Shakespeare's Hand in the Play of *Sir Thomas More*," edited by W. W. Greg, by kind permission of the Cambridge University Press

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Editorial Notes

To many of our readers, we doubt not, the splendid lines of Shakespeare which Sir Frederic Kenyon puts before them in this number will seem quite the greatest discovery that this journal has yet been privileged to commend to the English-reading world. They will note at once the succession of vivid pictures in the speech put into the mouth of Sir Thomas More; first, the throng of persecuted strangers, with their bundles and pitiful babies, driven out into new exile; then the rioters with a nationalistic cry, proudly triumphant over the forces of order; later, the same people, quelled by royal power and kneeling to beg for their lives; finally, a sweep of imagination which transfers the rioters as outlaws to foreign soil and depicts them there suffering at the hands of aliens the same savage cruelty, the same "mountainish inhumanity" as they had themselves inflicted on equally helpless strangers not long since.

All this is surely Shakespeare to the life; and not less so, to unite, as this speech does, condemnation of mob-rule, of "insolence and strong hand," keen foresight of its certain sequel, and pity for its victims—this on the one side,—with an appeal to the better feelings of the offenders on the other, and a promise of

mercy if they repent. Such capacity of sympathy with both parties may remind the student of Vergil, and of Horace; one detail suggests at once Horace's parallel picture of the peasants evicted to make the great man's pleasure-ground,

See, the outcasts fly,
Wife and husband, in their arms
Their father's gods, their squalid family.

And it may remind others of the pathetic scenes in London back-streets during the bombing-raids of the bad years which we have, somehow, survived.

In the course of More's appeal the royal power is idealised as the sign and surety of public order. There sounds the old Elizabethan ring, familiar in the English Prayer-book, but not often heard in later poetry. Yet, beside that, how much might have been written for and in our own time, for the month of February 1924 in Europe, in the British Isles? Have not Europe and England need of the plea against methods of violence, or against the bitterness of a narrow nationalism, in economic and political affairs? It was written for us, because its author was one of the immortals who wrote for all time. "A thing that is nobly spoken goeth sounding on for ever." In the imagination and in the insight which inspire these lines we may be confident that we have the genuine outcome of "Shakespeare's cloudless, boundless human view."

Nor ought we to rejoice in this new possession without gratitude to the patient work of many scholars which Sir Frederic Kenyon describes. To them we owe not merely the discovery of the passage in the midst of what is, comparatively, merely old playhouse-lumber, but the proof that we have a right to enjoy it as Shakespeare's own work. The methods of their testing may be seen by any who will read Sir Edward Maunde Thompson's or Mr. Dover Wilson's account of their respective lines of research; but how incredibly slow and tiresome, in itself and apart from its objects, such minute study would be, can hardly be guessed without some similar experience of prolonged micro-

scopic observation. But years of laborious sifting are amply, if rarely, rewarded by a jewel of such lustre as Shakespeare's own written draft of the speech of Sir Thomas More. Mr. Alfred Pollard's volume and Sir Frederic Kenyon's article are significant, though only as one token among a hundred others, of the way in which the staff of the British Museum is continually enriching us by creating knowledge as well as by preserving it.¹

There are, probably, good taxes; there are certainly bad taxes; and among the very worst is to be numbered the pernicious window-tax, which was levied in England from 1697 to 1851. It has left its mark in the blocked-up windows which are a common sight throughout the land. Perhaps the only service it paid to mankind was its inspiration of Pitt's famous pun, "Ex luce lucellum"—"From light a little profit." It is, however, only recently that we have come to recognise how vital to humanity's welfare is the light of the sun. We have not fully grasped the significance of modern discoveries even yet. There are thousands of houses throughout the land which are utterly unfit for human habitation owing to the eternal twilight which passes for their day. Even large town houses have basements which do not even approach a minimum standard in this respect. And we are better off in this country than in France, where a window-tax is still levied.

That all animal life is dependent, directly or indirectly, on plant life, and that plant life is dependent on the sun for its energy, are matters of common knowledge. But the immediate demand of animal life for sunlight is less generally recognised. This demand is most clearly shown by experiments on the production of rickets in animals. It is known that diet is an important factor in that disease, for the elusive vitamine, present in fresh fatty foodstuffs, can both prevent and cure rickets. But dark, insanitary surroundings can also cause rickets in puppies, even when the diet is adequate. It is reasonable to deduce that sunlight and open-air can cure rickets, and in fact this is so. But modern research has gone further than merely to show that in sunlight is health. In America the wave-length of light which is most efficient has been identified; it is found to be about 300μ —that is to say, in the ultra-violet part of the solar spectrum.² The mercury vapour lamp is very rich in this type of light, and really remarkable results have followed its use in London hospitals. The child is stripped,

¹ We owe an apology to any of our readers who noticed it for an error in the description of the play *Sir Thomas More* in a paragraph in our last issue.

² *Science Progress*, No. 71, January 1924.

and lies bathed in this light, and is kept warm by a large electric lamp. It gets as brown as an Arab, and improves in every respect in a remarkably short time.

The applications of this method are many. It is certain that tuberculosis in all its forms is a disease of darkness, ill-feeding, and over-crowding. Light, and especially ultra-violet light, is deadly to the tubercle bacillus. And the sun-cure of tuberculosis, which is carried out both in Switzerland and in England with great success, can be imitated by the ultra-violet light in hospitals. It is a remarkable fact that children whose skin does not darken in sunlight fail to derive benefit from the treatment. Many skin conditions, and many kinds of joint trouble, come also within the range of ultra-violet light treatment, which, it is safe to say, is in its infancy. But the lesson for mankind in general is quite clear. What sunlight, and artificial sunlight, can cure, they can prevent. There are legal restrictions on basement-building and similar unhealthy housing arrangements to-day. They must be extended; the reforms which began with the repeal of the window-tax must be developed until the undermining of the health of the nation's childhood becomes, once and for all, made impossible.

The British Empire Exhibition, which was first proposed in 1913 by the late Lord Strathcona, and which has been in process of organisation since 1920, will be opened very shortly. There can be no question as to the prospect of the most varied appeal which it will make to every inhabitant of the Empire. Those whose interest is largely in the developments of modern science and industry will have a unique opportunity of studying them in the very complete series of demonstrations which have been designed. There are to be, for example, reproductions of a modern coal-mine, and a display of the whole process of rubber manufacture, which is now to a surprisingly large degree the monopoly of the British Empire.

The history of rubber is a romance in itself; but what industry has not its romances? It was long known to the inhabitants of the banks of the Amazons, who made boots and bottles of the juice of the tree which they called "Hévé." It was discovered by a French scientist, La Condamine, in 1736, but not until 1830 was it employed in Europe to any large extent. At that time all the rubber used came from the Amazon district, and it was very different from the india-rubber of to-day. It became sticky near a fire, and stiff in the cold. There were two great events in the

history of its development. One was the discovery of vulcanisation by sulphur, due to Thomas Hancock, by which means the product which we recognise to-day was manufactured.¹ The other was the exploit of Sir Henry Wickham, who managed to bring 70,000 rubber seeds to Kew in 1876. From these about 3,000 plants were grown and exported to Malay. To-day more than 300,000 tons of rubber are produced yearly from the descendants of these seeds, and only 20,000 tons from the wild rubber trees of Brazil. The experiments of scientists in introducing alien plants and animals into a country have not always been a success, as the menace of the rabbit in Australia teaches only too clearly; but the enterprise of Sir Henry Wickham was a happy inspiration which has made no small contribution to the wealth and the greatness of the British Empire.

There must be something infectious in excavation, or at least in popular interest in it. The discovery of the glories of Tutankhamen's tomb have been followed by the announcement of many other discoveries throughout the East. One is reminded of an incident in Maubeuge just after the Armistice. A woman approached the C.O. of an R.A.F. Squadron, and asked for permission to dig. It was granted, and she quickly exposed a jewel-case, hidden on the approach of the enemy nearly five years previously. Every member of the squadron was to be seen digging for a week afterwards; but, alas! there were no more jewel-cases to be found. The archaeologist is more fortunate. In Palestine and in Mesopotamia there seems an inexhaustible supply of sites yielding results of the greatest interest to the excavator. The most recent announcement, made in the *Times* of January 29, describes the investigation of the ancient burial-ground of the kings of Byblos in Syria. One of them had attracted unofficial interest, and contained only an English copy-book, bearing the date 1851. But others revealed many treasures—silver pots and golden plaques, all showing clearly the influence of Egypt. They date, according to Professor Pierre Montet, from a period thirty-seven centuries ago.

When our age is dead and forgotten, what records will remain to the excavator of four thousand years hence? Our pictures will have faded and rotted away; the art of sculpture is little accounted of to-day. It is true that Horace boasted that his poems were a memorial more lasting than bronze, and that his boast has been justified. We may hope that the best of our literature will remain—and even more

¹ *The Chemistry of Rubber*. By B. D. W. Luff, F.I.C. (Ernest Benn, Ltd., 25s.)

sincerely that the worst of it will be lost. But our burial customs are too rational to preserve our tawdry jewellery and our machine-made domestic ware. Perhaps if some cataclysm overwhelms us, we may only leave behind us some tangled wreckage of wheels and rusted iron. And who can tell? Perhaps that might be a fit epitaph to our age, as the massive extravagance of Egypt tells the story of their long-forgotten kings.

The attention of the public in many lands has of late been painfully directed to petroleum. In this country the amazing and inexplicable variations in its price are a constant mystery; beyond the Atlantic the intricacies of its financial strategy have been equally mysterious. To the chemist it has always been a little unsatisfactory. There is no real agreement as to its origin. "The famous Russian chemist Mendeleef," as Sir Arthur Shipley writes in his latest book,¹ "supposed that oil was formed by the action of water on metallic carbides existing in the heated interior of the earth, a process exactly analogous to the formation of acetylene from calcium carbide, but the balance of public opinion now inclines strongly to the view that oil and gas are formed by the natural distillation of organic material entombed ages ago in the rocks. . . . Many large fossil Brachiopods found in the carboniferous limestone in Derbyshire and Yorkshire contain lumps of bitumen exactly like the residue left on distillation of oil, i.e. asphalt." If petroleum is derived from organic matter, that matter must have consisted of seaweeds, as oil is usually found in rocks of marine origin, and nearly always associated with salt water. So the green plant, once more, appears as the great source of energy on this earth. "It is chlorophyll (the pigment of plants) which makes the world go round," as Sir Arthur Shipley says.

In this number we publish, at the request of numerous readers, an article dealing with modern theories of the structure of the atom. No line of research is so "live," especially in this country, as the investigations of the problems raised by the pioneer work of Sir J. J. Thomson and Sir Ernest Rutherford. It is often asked, "What use is all this knowledge?" "To this natural and not unwarranted question," write two recent authors,² "we may first give the very general answer, that progress in our knowledge of the laws of nature always contributes sooner or later, directly or indirectly, to increase our mastery over nature."

¹ *Life: An Introduction to the Study of Biology*. By Sir A. E. Shipley. Cambridge University Press, 6s.

² *The Atom and the Bohr Theory of its Structure*. By H. A. Kramer and H. Holst Gylendal. 10s. 6d.

An Autograph of Shakespeare

By Sir F. G. Kenyon, K.C.B., F.B.A.

UNTIL quite recently it was accepted as certain, not merely that no play or portion of a play by Shakespeare had come down to us in his own handwriting, but that no specimens of his writing were in existence with the exception of six signatures. Three of these are appended to the three sheets of his Will, written on March 25, 1616 (less than a month before his death), and now in Somerset House. One is attached to the conveyance of a house purchased by Shakespeare in Blackfriars, dated March 10, 1613; and another, dated on the day following, to a mortgage of the same property: these are respectively in the Guildhall Library and the British Museum. The sixth (discovered by an American scholar, Dr. C. W. Wallace, so lately as 1910) is in the Public Record Office, and consists of his signature in a law-suit, dated May 11, 1612. All were written after the date at which, according to our best evidence, Shakespeare had written his last play and retired to Stratford-on-Avon. In the three earliest of them the name is not even written at full length, but in various forms of abbreviation. Only in the case of the last signature to his Will is anything written beyond the mere name. Here we have the words "By me William Shakespeare." These two words, "By me," were, until recently, believed to be the only words, apart from his own name, that have come down to us in the hand of the greatest writer of the English language.

There was, after all, nothing very surprising in this. The original manuscripts of the plays of most of Shakespeare's contemporaries had perished with equal completeness. Two of Ben Jonson's masques, in his own hand, are in the British Museum. One play by Massinger, *Believe as You List*, was identified by Sir George Warner in 1900 as being in the poet's autograph, and was secured very cheaply for the British Museum. But that is nearly all. Of Marlowe, Beaumont, Fletcher, Webster, Ford, Chapman, and many others of the contemporaries of Shakespeare, no play survives in their own hands. It was not the practice of the time to attach importance to the author's autograph. After it had served its purpose, perhaps as a prompt-copy in the theatre, or as copy for a printed edition, it was allowed to perish; and Shakespeare's autographs went the way of all the rest.

A Play by Many Writers

The discovery—if, as I believe, it be a discovery—not of a whole play, but of a considerable passage, in

Shakespeare's own hand is therefore a literary event of no small interest. It is not wholly a new discovery, but it is only quite recently that criticism has brought to light its true character. Among the manuscripts collected by Robert and Edward Harley, first and second Earls of Oxford, to receive which (with the Sloane and Cotton libraries) the British Museum was founded in 1753, is one (numbered 7368) which contains a play entitled *Sir Thomas More*. As a whole, it is not a work of much literary merit. The author of the main body of it is now known to be one Anthony Munday; and thirteen out of the twenty leaves of which it consists are in his hand. The other seven contain additional or substituted passages by no less than five different writers—a striking example of the manner in which, in the Elizabethan and Jacobean period, plays were modified and rewritten to suit the requirements of the theatre.

Now, of all these additions, one (occupying three pages of the manuscript, with one blank page) stands out above all the rest in literary merit. It is "a scene representing the insurrection of the London apprentices against the aliens resident in the city, which was quelled by the intervention of More, then sheriff."¹ The vigour and dramatic genius of this scene may be judged from a quotation (in modernised spelling) of its most striking passages:

More. Grant them removed, and grant that this your noise
Hath chid down all the majesty of England;
Imagine that you see the wretched strangers,
Their babies at their backs, with their poor luggage,
Plodding to the ports and coasts for transportation,
And that you sit as kings in your desires,
Authority quite silenced by your brawls,
And you in ruff of your opinions clothed,
What had you got? I'll tell you: you had taught
How insolence and strong hand should prevail,
How order should be quelled; and by this pattern
Not one of you should live an aged man,
For other ruffians, as their fancies wrought,
With self-same hand, self reasons, and self right
Would shark on you, and men like ravenous fishes
Would feed on one another. . . .

. . . What do you then,
Rising 'gainst him that God himself instals,
But rise 'gainst God? What do you to your souls
In doing this? O desperate as you are,
Wash your foul minds with tears, and those same hands,
That you like rebels lift against the peace,
Lift up for peace, and your unreverent knees,
Make them your feet, to kneel to be forgiven.

. . . Say now the king,
As he is clement, if the offender mourn,
Should so much come too short of your great trespass
As but to banish you, whither would you go?

¹ Sir E. Maunde Thompson, *Shakespeare's Handwriting*, p. 30 (Oxford, 1916).

What country, by the nature of your error,
Should give you harbour? Go you to France or Flanders,
To any German province, Spain or Portugal,
Nay, anywhere that not adheres to England,
Why, you must needs be strangers, Would you be pleased
To find a nation of such barbarous temper,
That breaking out in hideous violence
Would not afford you an abode on earth,
Whet their detested knives against your throats,
Spurn you like dogs, and like as if that God
Owed not nor made not you, nor that the elements
Were not all appropriate to your comforts,
But chartered unto them? What would you think
To be thus used? This is the strangers' case,
And this your mountainish (?) inhumanity.

It is surely not difficult to discern the hand of Shakespeare here, and it is not surprising that more than one

hand. He remarked that Shakespeare's writing, as it appears in his signatures, was that of the ordinary copyist of the time, i.e. was the English, not the Italian, script; but he was not an expert in palæographical science, and was consequently unable to push home the argument on this side. His suggestion consequently, though backed by James Spedding, attracted little attention, and was put aside as a mere fancy.

At this point, as a basis for what is to follow, I may perhaps be allowed to state the opinions which I had myself formed before the publication of the researches which have raised the possibility observed by Mr. Simpson to a very high degree of probability. On the literary side I held, and still hold, most emphatically that the lines are Shakespeare's and could have been



SHAKESPEARE'S SIGNATURES TO THE THREE PAGES OF HIS WILL.

From *Shakespeare's Hand in the play of Sir Thomas More*, edited by W. W. Greg.

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competent critic has assigned this passage to him on literary grounds alone.

The Nature of the Evidence

But is it not possible to go further? This scene, so markedly superior in style and power, is written in a hand different from that of any of the other contributors to the manuscript; and the corrections that are made in it are of such a kind as to suggest most forcibly that the scribe of these lines was also their author. On these grounds the possibility was first noted by Mr. Richard Simpson, in 1871, that we might have here a manuscript in Shakespeare's own

written by no other dramatist alive about 1593, which Mr. Pollard has shown to be the most probable date for the play.¹ Indeed, I would go further, and say that of all the Shakespeare Apocrypha (the plays or scenes attributed to Shakespeare which do not appear among his traditionally accepted works) this is the only passage which carries conviction to my mind. On the other hand, my impression of the handwriting was that it was just the kind of hand which the writer of the Shakespeare signatures *might* have written.

¹ *Shakespeare's Hand in the Play of Sir Thomas More*, pp. 18, 22. (Cambridge, 1923.) Other suggested dates range between 1586 and 1599.

ment; but a careful study of the *More* MS. satisfied him that the hand of the riot scene corresponded in all respects with the hand of the Shakespeare signatures. This conclusion was set out in full detail, with a separate study of each single letter, in his volume entitled *Shakespeare's Handwriting*, which appeared at the end of 1916.

The war, and the perturbations resulting therefrom, disturbed and delayed literary researches; but the textual study of Shakespeare has recently been followed up with especial intensity by a small group of highly competent scholars, who in the autumn of 1923 produced the volume which is the special occasion of this article.¹ Mr. A. W. Pollard (who may be described as the general inspirer of the group) contributes an introduction on the character of the play, its bibliographical history, its date and occasion, and the problem of the three pages. Mr. Greg describes the six different hands concerned in the manuscript. Sir E. Maunde Thompson repeats, in even greater detail, his study of the Shakespeare signatures and the writing of the three pages. Mr. Dover Wilson brings a new line of argument to bear by pointing out remarkable parallels between the three pages and the evidence obtainable as to Shakespeare's writing from the contemporary quarto editions of some of his plays which there is most reason to believe were printed from his own manuscript. Finally, Mr. Chambers shows how closely the political and social ideas expressed in *More's* speech correspond with those of Shakespeare as they appear in such plays as *Coriolanus*, *Julius Cæsar*, *Troilus and Cressida*, and the Jack Cade scenes in *2 Henry VI*. It is a fascinating study, and will, I think, convince many that the resemblances are not superficial, and that the attitude displayed towards the populace is markedly individual and such as we easily associate with the widely tolerant and sympathetic mind of Shakespeare, which yet clung to order and discipline as the safeguard of a State.

The strength of the argument for the Shakespearean penmanship of these three pages is the convergence of two totally distinct lines of evidence—the literary and the palæographical. Either separately might fail to carry conviction; but when we have, on the one hand, the literary argument that these lines are strongly Shakespearean in style, and on the other the palæographical argument that the hand in which these lines are written has all the characteristics which are found in Shakespeare's signatures, while the corrections in the manuscript are those of an author, not of a

scribe, the total proof comes very near to demonstration. Both lines of argument have been immensely strengthened by the study and researches of Sir E. Maunde Thompson and of Mr. Pollard and his colleagues; and henceforth the visitor to the Manuscript Saloon of the British Museum may feel with substantial confidence that he is indeed looking on a scene written by the actual hand of the author of *Hamlet*.

The Importance of the Discovery

The importance of this conclusion is not merely sentimental. To know an author's handwriting is often to have a clue to the corruptions which have crept into his text. Our knowledge of Shakespeare's plays rests in the main on the First Folio of 1623, produced by his literary executors, Heminge and Condell, who tell us that they made use of his original MSS. Only in a few instances have we also quarto editions of single plays, published in his lifetime, which can be supposed to rest on an equally good authority. Now, Shakespeare's handwriting, whether in his signatures or in the *More* MS., though fluent enough, is not carefully formed, and lends itself easily to misunderstanding by printers. Such misunderstandings unquestionably underlie many of the difficulties and obscurities which abound in his printed text. Hitherto critics and editors have had to rely on their own intuition for the correction of such passages. Now we have an additional instrument ready to our hand, for it is possible to judge how Shakespeare would have written the words in question, and how they might have been misread by a careless or uneducated compositor. Indeed, in some passages of the *More* MS. even experts may differ as to the letters or words intended.

Therefore, by the discovery which has been brought to its climax in the centenary year of the First Folio, not only have we gained (with the satisfaction of knowing that it is safely enshrined in our National library) a personal relic of our great poet of immeasurable sentimental interest, but we have also acquired a more valuable engine for the purification of his text and for the fuller comprehension of his incomparable genius.

A NEW TYPE OF RAILWAY ENGINE

It is reported in the *Observer* for February 17, 1924, that a new type of engine has been successfully tried on the Roma-Nord line in Italy. The motive power is compressed air, and it is said to be exceedingly economical to run. Certainly the advantage of smokelessness is a point considerably in its favour. It is the invention of a young Roman engineer, Fasuto Zarlatti. Italy, which is entirely dependant for its coal supply on external sources, would find a successful engine of this type a great advantage.

¹ *Shakespeare's Hand in the Play of Sir Thomas More*: Papers by Alfred W. Pollard, W. W. Greg, E. Maunde Thompson, J. Dover Wilson, and R. W. Chambers. (Cambridge University Press, 1923.)

Spectra and the Structure of the Atom

By R. W. James, M.A.

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It is probable that most scientific men during the last century have believed that the comparatively few different kinds of chemical atom from which all natural bodies are built up were themselves complex, and not indivisible, as the name "atom" implies, and were moreover constructed out of simpler units common to all. The discovery of Newlands and Mendeleef that, if all the chemical elements were arranged in a series in the order of the relative weights of their atoms, definite chemical properties recurred periodically in the series, was in itself proof enough that the atoms of the different elements were not all independent. In fact, the evidence for the view that the properties of the different atoms were merely a question of the number and arrangement of certain units common to them all was very strong. It is, however, only within the last twenty-five or thirty years that definite experimental evidence as to the nature of these common units has been forthcoming.

We must date the beginning of the new atomic physics to the proof, mainly through the researches of Sir J. J. Thomson, that negative electricity is atomic in nature. It was shown that negative electricity could not be subdivided indefinitely; the smallest possible negative charge had a finite value. To this ultimate particle of negative electricity the name "electron" was given. The electron is apparently always exactly the same, from whatever source it comes. It has a definite mass which is about $\frac{1}{1850}$ part of the mass of the hydrogen atom, and it has a small, but perfectly definite and constant charge. It soon became evident that the electron was one, at least, of the common constituents of the atoms of all elements. But since matter on the whole is electrically neutral, there must be in the atom an amount of positive electricity sufficient to balance the negative charge on the electrons contained in it, and, since the electrons are so very light, there must be, besides these, some part of the atom with which its main weight is associated.

We now know, thanks largely to the work of Rutherford, that nearly the whole of the mass of the atom is concentrated in a nucleus whose dimensions are extremely small compared with those of the atom as a whole. This nucleus carries a positive charge, and is surrounded by a cloud of electrons, whose number is just sufficient to balance the nuclear charge, by which they are attracted. The lightest atom of all,

hydrogen, consists of one electron and a nuclear charge of one positive unit, the next heaviest atom, helium, of a nucleus with two positive units and two electrons, and so on through the whole series of elements. If we call the number of an element in the atomic series its atomic number, then the nuclear charge and the number of electrons in the atom of the element are each equal to the atomic number.

Within the Atom

The interesting question at once arises, What is the arrangement of the electrons within the atom? It is fairly clear that the electrons cannot be at rest. Let us consider the atom of hydrogen with its nucleus and one electron. There will be a force of attraction between the two, proportional to the product of their charges and inversely proportional to the square of the distance between them; in fact, the law of attraction is of exactly the same form as that between a planet and the sun. The electron will thus fall towards the nucleus, unless it already possesses a velocity in some other direction, just as the earth would fall into the sun if its velocity in its orbit were suddenly checked. We must consider then, that the electron describes an orbit round its nucleus just as a planet describes an orbit round the sun, and, since the law of attraction is the same in the two cases, this orbit will also be an ellipse, or in special cases a circle. We have considered the simplest case, when there is only one electron. As soon as we come to the next case, that of helium, the mathematics of the problem becomes much more complicated. The problem of even two electrons moving round a nucleus is in general insoluble in finite terms; but we can say that, in the more complex atoms, the electrons will all describe orbits of some kind round the nucleus, although these may differ largely from ellipses owing to their mutual repulsions.

It is evidently one of the most important problems in physics to determine, at any rate approximately, the form of the electron orbits in the more complicated atoms. Within the last few years a good deal of progress has been made in this direction, by studying the spectra emitted by the atoms. It is of course well known that each kind of atom, under suitable stimulus, may be made to emit light, and that the light from any particular kind of atom, if analysed by a spectroscope, shows spectrum lines which are characteristic of that atom. Light is known to be a periodic electro-magnetic disturbance of the same essential nature as the waves employed in wireless telegraphy. The difference between the two kinds of wave is one of length only. Where wireless waves are measured in hundreds of metres, light waves are to be measured in hundred-thousandths of centi-

metres, and the frequency is correspondingly greater. For example, at any point over which blue light is passing, we have an electric field which is oscillating with a frequency of about a thousand billion per second.

X-ray Analysis

Every line in an optical spectrum corresponds to an electro-magnetic vibration of a definite frequency emitted by the atom giving the spectrum, and, by measuring the wave-lengths corresponding to the lines in the spectrum, we can determine the frequency of the electro-magnetic waves which the atom is able to emit. To these optical vibrations we must add the characteristic X-ray vibrations of the atom. Each element, if used as the target in an X-ray bulb, can be made to emit X-rays. These rays are again electro-magnetic waves of the same nature as light, but having a frequency some ten thousand times greater. The X-ray frequencies belonging to the atom can be determined by using a crystal to measure the wave-lengths of the rays. Each atom, then, can in general emit electromagnetic waves of a great range of frequencies. It is as if it were a broadcasting station capable of working on wave-lengths varying from a few thousandths to a few hundred-millionths of a millimetre.

The origin of these waves is evidently to be sought in the electrons moving in their orbits around the nucleus. At first sight the explanation seems simple. An electric charge rotating with high speed about the nucleus should, according to the classical electro-magnetic theory, set up electric and magnetic vibrations in the ether, the frequency of the vibrations being that of the electron in its orbit. The different spectrum lines on this view should represent the different electron orbits in the atom. But an examination of the actual facts of the case shows at once that this simple explanation will not do.

Let us go back to the case of the hydrogen atom, which we know consists of a single electron revolving round its nucleus. If an electric discharge is passed through hydrogen gas at low pressure, the hydrogen emits a characteristic spectrum. This consists of a bright red line, a blue-green line, a violet line, and a number of other lines in the ultra-violet region of the spectrum which cannot be seen but can be photographed. As many as thirty-three different lines have actually been measured in the hydrogen spectrum from some stars. This is evidently too complicated a series of frequencies to be emitted, on our simple assumption, by a single electron revolving about a nucleus. There is, moreover, another difficulty in this simple view. We have supposed, that as the electron revolves about the nucleus, it emits electro-magnetic radiation. This means that the revolving electron is emitting a stream

of energy, and hence its own energy must be diminishing. The emission of energy will act as a brake on the electron and slow it down, so that it will begin to fall towards the nucleus. Thus the orbit will get smaller and smaller and the speed of revolution greater and greater, so that the frequency emitted will also increase, instead of remaining constant as it actually does. Moreover we should conclude that atoms would continuously decrease in size as they emitted radiation, and there is not the least evidence that this is the case.

Bohr's Theory

In this unsatisfactory state, the theory of the hydrogen spectrum was taken up by Bohr in 1913. It had been discovered by Balmer in 1885 that there was a remarkably simple relationship between the frequencies of the different lines in the ordinary hydrogen spectrum. The lines form a series, getting closer and closer together as we go from the red end of the spectrum towards the violet, and finally crowding up towards a limit in the ultra-violet, known as the head of the series. But the important thing to notice is that the frequency of every line in the series can be expressed as a difference of two terms, one a constant one which is equal to the frequency of the head of the series, the second a variable one changing from line to line of the series simply by increasing a whole number contained in the formula for the term by one unit, in going from one line to the next.

Bohr set himself to explain the meaning of these terms, from the difference of which the lines of the spectrum could be obtained, since it was evident that they must have some definite physical significance. To do this he had to modify slightly the simple picture of the electron behaving as a planet around the nucleus. It had already been necessary to modify somewhat the classical laws of dynamics in considering the radiation of heat from a hot body. Planck about 1901 had been led to the view that energy could not be radiated as heat and light in indefinitely small amounts. To explain the laws of radiation, he had to assume that emission of energy could only take place in "quanta" of finite size, the size of the quantum being proportional to the frequency of the radiation emitted. Bohr applied this quantum theory to the radiation emitted by an atom of hydrogen, combining it with a new idea of his own. This idea was briefly as follows. On the ordinary astronomical theory, any orbit should be possible for the electron round its nucleus; the size and shape of the orbit would merely depend on the speed and direction of motion of the electron at the instant at which it was caught by the attraction of the nucleus. Bohr supposed that this was not the case, but that only certain orbits were possible as

stable ones. He supposed that while the electron was revolving in one of these orbits, which he called stationary states, it radiated no energy. The particular stationary orbits which were possible were defined in a certain way which we need not here consider.

Now, to remove an electron moving in any particular orbit entirely from the attraction of the nucleus, it will be necessary to do a certain amount of work. Let us call this work the energy of the orbit. It will be greatest for the orbit closest to the nucleus in which the electron will move in the normal state of the atom.

Now, suppose a certain amount of energy is communicated in some way to the atom, for example, by heat or by the electric discharge. This energy may remove the electron from the innermost, or normal orbit, and lift it to one of the outer ones. The atom is now, so to speak, at "full-cock"; it is ready to emit radiation.

The electron will always tend to fall back to one of the stationary orbits nearer to the nucleus. When it does this, an amount of energy is set free, equal to the work which was done originally in lifting it from this inner orbit. Bohr's assumption is that the energy is set free as electro-magnetic radiation, and, moreover, that it is set free as *one single quantum* of radiation of a definite frequency. Applying now Planck's law that the quantum of energy is a constant (" h ") multiplied by the frequency of the radiation, we can calculate the frequency of the radiation emitted, when the electron falls from one orbit to another, simply by dividing the difference in the energies of the two orbits by Planck's constant h .

Thus on this view, the "terms" from which the hydrogen series lines can be derived are simply the energies of the different stationary orbits divided by the constant h . Every line has a frequency which is the difference of two such terms, and corresponds to the passage of an electron from one of these stationary orbits to another. If the electron falls from one of the outer orbits to the orbit next but one to the nucleus, a line in the Balmer series, described above, is produced. If, however, it falls to the innermost orbit, it gives rise to a line in another series in the ultra-violet which has been observed by Lyman.

Now, in the spectra of the other elements we can trace series similar to those of the hydrogen spectrum, although of course owing to the greater complexity of the atoms they are less simple. Here again we must suppose that the terms from which the frequencies of the lines of the series can be derived represent the energies of different possible stationary electron orbits in the atom. By studying the spectra we can therefore get the energies of the orbits.

Atomic Structure and Chemical Properties

If we consider the way in which the optical spectra of the elements change as we go from element to element in the atomic series, we find that they show a periodicity which follows that of the chemical properties. Now, the chemical properties are certainly due to the outermost electrons of the atom, and thus we can conclude that the same is true of the optical spectra.

The periodicity of the chemical properties of the atom appears to be due to the successive completion of groups of electrons in the atom and the beginning of new ones. As electron after electron is added, going from one element to the next, a very stable arrangement is reached from time to time. The atoms in which these stable configurations occur are those of the inert gases, all of which have a similar lack of chemical properties. When the next electron is added it cannot break into the stable group, but has to start building up a new set of orbits which will be completed at the next inert gas. The electrons from one of the outer groups penetrate, during their revolutions, into the inner groups, but spend most of their time outside and can thus be spoken of as the outer electrons. It can be seen that the state of the outer electrons in the same stage of formation of the group will be much the same for the successive groups, and thus we get the periodic recurrence of the chemical properties, and a similar, though less well marked, periodicity of optical spectra.

With X-ray-spectra of highest frequency no such periodicity occurs. The frequency of the X-rays increases steadily from element to element as the atomic number increases. There is no doubt that it is the innermost electron-groups of the atom which are concerned in the emission of X-ray-spectra. To excite an atom to emit such rays, an electron has first to be removed from an orbit close to the nucleus. The work required to do this depends mainly on the nuclear charge, and thus increases steadily from element to element. The emission of X-rays takes place when the vacant orbit is filled up by an electron falling in from one of the outer groups of the atom. The frequency of the ray is again a difference of two terms, one corresponding to the energy of the innermost orbit, the other to the orbit from which the electron has dropped. Thus, by studying the X-ray terms we may get an idea of the energies of the different inner groups of electrons and thus some notion of the sizes and shapes of the orbits.

We see that to explain optical and X-ray spectra, it is necessary to make certain assumptions which seem to be at variance with the older mechanical ideas. This should not surprise us too much. We must

remember that the ordinary laws of mechanics are experimental laws, only to be considered true so long as they do not predict things not verified by experiment. They were discovered by considering the behaviour of bodies containing huge numbers of atoms; it is not surprising that they do not apply within the atom itself. To enlarge and supplement these laws and to discover the new laws which do apply within the atom and to link them up to the old ones, is the task of modern physics.

Some Modern Egyptian Saints—II

Coptic Saints¹

By Winifred S. Blackman, F.R.A.I.

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IN the previous article I dealt with the cults which have sprung up in connection with the veneration paid to Moslim sheikhs, either living or dead. In this I propose to deal with saints who are specially honoured by the Copts, and who accordingly receive the appellation *Māri*.

A Coptic saint is usually buried within the precincts of some monastery or church, which, indeed, may be dedicated to him. A popular saint may be honoured by the dedication of numerous monasteries and churches to his memory, in all of which he is equally venerated.

Sometimes the same saint may be claimed by Moslims and Copts alike, in which case the grave is usually situated in some open space, possibly under the shadow of a tree or trees, the lower branches of which are covered with votive offerings contributed by the followers of both religions. With the Christians, as with the Moslims, candles are a favourite form of votive offering, and, when the saint is claimed by the adherents of both faiths, their candles may be seen burning side by side.

A Saint of Two Faiths

In one of the provinces of Upper Egypt, far away from the haunts of the tourist, lie the remains of the Sheikh Abu 'Agūr, as he is called by the Moslims, though to the Christians he is known as Saint Mittias el-'Agirmi, for the partisans of both religions claim him.

¹ The material utilised in the following article was collected by me in the course of my expedition in Egypt during the past winter and spring (1922-3), the funds being provided by the Trustees of the Percy Sladen Memorial Fund, supplemented by a grant from the Royal Society.

He is said to be buried under a *sant*-tree (prickly acacia) in the cultivation, the site being further marked by a low wall of bricks, partly enclosing it, and an erection in burnt clay which was originally made to form part of a pigeon-house (*burg*). From the lower branches of the tree hang a number of handkerchiefs, all more or less ragged, which are the votive offerings of Moslims and Christians alike (see Fig. 3). The pottery erection provides a shelter in which candles presented by followers of the two religions, can be burnt, a further niche for this form of offering being built into the low wall. The sacred spot is covered with water during the inundation, so at that period the pottery erection is removed and placed on a narrow road which runs through the fields out of reach of the flood. Thus all those who wish to honour the saint or to ask for his aid can come and make their prayers and offerings to him during the time that the actual burial-site is inaccessible. Lights from the candles dedicated to the saint shine brightly at night from the pottery shrine placed by the roadside, while during the day-time other votive offerings, in the form of coloured handkerchiefs, are seen waving triumphantly from short sticks stuck up in the ground around it. The sheikh is visited every Friday by the Moslims, but visits from Christians may be paid any day in the week. The Moslims definitely associate the sheikh with the tree under which he is said to be buried, but the Christians affirm that he is buried in a church, which they believe still exists underground at this spot. The Christians state, moreover, that when they visit the site on a Sunday they can smell the incense coming up from underground, for every Sunday the good Saint Mittias worships in this subterranean church. They will not allow the Moslims to build a tomb there, though the latter continue to claim the saint as a follower of their Prophet. The association of a sheikh and a Christian saint with this tree and special site dates back, so I was informed, for two hundred years or more.

The following are stories circulated in the neighbourhood extolling the powers of *Māri Mittias*.

A young boy, now eight years old, was, up to last year, crippled by a stiff leg which was permanently bent up at the knee, so that he could not walk without the aid of a stick. One day his elder brother bethought him of the Sheikh Abu 'Agūr, and took his little brother to the holy tree and made him lie down on the ground under its shade, with his stick beside him. For three hours the boy slept soundly on the sacred spot, at the end of which time he dreamt that a man, who was dressed in very fine clothes, took the stick and with it struck him over his lame leg. This treatment made him cry out, and he jumped up and stood on both feet for the first time in his life, for hitherto

he had never been able to put his lame foot on the ground. He then walked off to his house in a neighbouring village. Since this miraculous visitation of the sheikh the boy, who is a Copt, walks well without any assistance. The cure appears to be permanent.

The small plot of land surrounding the tree of the Sheikh Abu 'Agūr also belongs to him, and is in no sense public property. A certain amount of *ħalfa*-grass grows on part of the ground (see Fig. 3), and one day a man picked some of this grass and began to twist it into a rope. While he was thus engaged one of his arms and hands became paralysed, so he went to consult a doctor in the capital of the province in which he lived. The doctor, after examining the hand and arm thus affected, said that they had been poisoned, and declared that immediate amputation was necessary. The operation was accordingly performed, and the man still believes that he has to suffer the loss

and bring cattle which are slaughtered at the churches. The bread and meat are distributed among the poor, who flock in great numbers on these occasions to all the churches dedicated to him.

In a certain village in Asyūt Province there is a Coptic church dedicated to Saint Egladiūs el-'Azab (see Fig. 2), and a man who lives close to the sacred building was, on one occasion, entertaining a Moslim friend who had arrived from another province. While they were engaged in conversation together the talk turned on to the subject of sheikhs, and the Moslim remarked that the Copts had no real saints, but that what they believed about their so-called saints was all rubbish. To this his host replied, "That is not so; we have a celebrated saint to whom the church close by is dedicated." But his guest scoffed at the idea.

At night, when the Moslim was sleeping in a room in the upper story of the house—his host sleeping on the ground-floor—a young man appeared before him, and touched him to wake him from his slumbers. This uninvited guest then seized the Moslim by the throat and asked him how he dared to speak of the Coptic saints in the scornful way he had done.

Meanwhile the host, hearing his guest choking, and crying out, "Leave me, leave me! I am wrong, I am wrong!" rushed up, thinking that he was being attacked by thieves. When he arrived on the scene he found his guest weeping, so he asked him what was the matter. The Moslim then told him of his unexpected visitor, and described his appearance. From the description the host knew that the mysterious person was the great saint himself. So loud had been the cries of the terrified Moslim that the whole neighbourhood had heard him.

On the following morning the now repentant Moslim repaired to the church dedicated to Saint Egladiūs el-'Azab, and, with shoes hanging round his neck, he knelt before the altar and prayed to the saint, saying, "Pardon me, pardon me, pardon me!" After this he left the church.

Since this visitation of the saint the Moslim, who still remains a follower of Islām, sends every year a gift of wax for the manufacture of candles used in the services held in the church, together with a present of incense.

It must be explained here that it is the custom all over Egypt, when a Copt or a Moslim has committed a wrong against a saint or sheikh, for him to repair to the church or mosque and borrow a pair of shoes such as are worn by poor *fellāḥīn*. These shoes are suspended by a cord round the neck of the penitent, who must wear them in this way as he kneels before the altar, or *kibleh*,¹ as the case may be. As he kneels he must repeat the words "pardon me," seven, five, or three

¹ The prayer-niche turned towards Mecca.

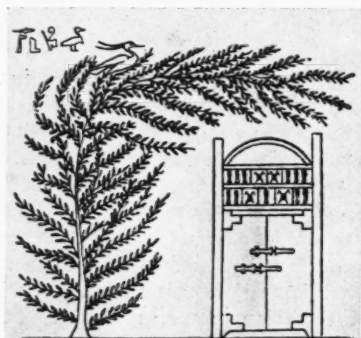


FIG. 1.—SHRINE OF OSIRIS, OVERSHADOWED BY A TREE UPON WHICH RESTS THE BAI OF OSIRIS IN THE FORM OF A HERON.

After Wilkinson, *The Ancient Egyptians* (London 1878), iii, p. 349.

of an arm as a punishment for stealing the *ħalfa*-grass belonging to the Sheikh Abu 'Agūr.

We will now turn to beliefs connected with saints of the Coptic Church only.

Saint Egladiūs and the Unbelieving Guest

Egladiūs el-'Azab is a saint of great repute. Several churches in Egypt are dedicated to him, and his body lies with those of four other saints in a special edifice set apart for them in a large town in Upper Egypt. The bodies of these five holy men are still in a good state of preservation, though they have all been dead for a long period of time. Each body lies in a coffin. The saint in question was very young when he died, having been killed, so I was told, by the Arabs because he was a Christian. He wears a wide ribbon of gold across his breast, and a gold ear-ring in one ear. A special festival is held every year in honour of the Saint Egladiūs el-'Azab, for the due celebration of which the people make large quantities of bread

times, the number of repetitions being decided by the priest or *imām* present in the church or mosque. When this act of repentance is finished, the man goes

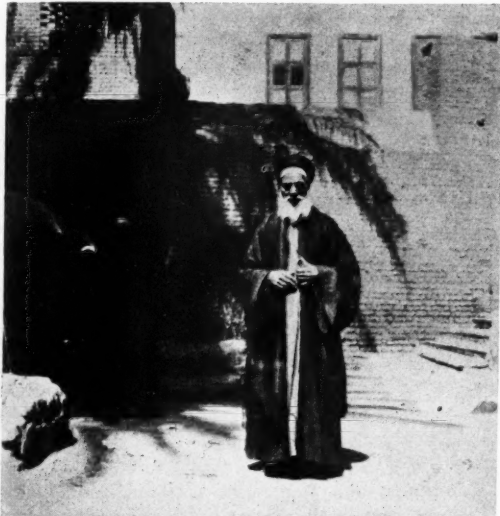


FIG. 2.—THE SPACE OUTSIDE THE CHURCH OF SAINT EGLADIŪS EL-'AZAB, WITH THE PRIEST OF THE CHURCH.

out and returns the shoes to the original owner. The shoes must always be those of a very poor *fellāh* who is in wretched circumstances, thus indicating the attitude of mind of the penitent man in the presence of the saint or sheikh whom he has wronged.

With regard to the offering of wax, it may be of interest to explain that the candles used in religious ceremonies in the Coptic Church are always made by the priest himself, or else by the servant who is responsible for the cleaning of the church.

The Stolen Vestments

The following story is also connected with Saint Egladiūs el-'Azab, the incidents related therein having taken place in the same village as those mentioned in the previous story. Near this village there is a much smaller one, in which reside a number of Copts. When one of their number dies, the body is always brought to the church dedicated to this celebrated saint in the larger village, where the service is held before the body is taken to be buried in the vast cemetery adjoining a great monastery a few miles distant.

One day a Copt in the smaller village died, and his body was brought to the church of Saint Egladiūs el-'Azab, where the service was to be held. The coffin was placed before the altar, awaiting the arrival of the priest. Among the people present was a certain number of Moslims. The vestments worn by the priest

at the celebration of the Eucharist happened, at the time of the funeral, to be lying on the altar, tied up in a handkerchief. One of the Moslims present, seeing this bundle and thinking that there might be some good clothes or valuable vessels of gold in it, took it and carried it away under his arm, carefully concealing it by covering it up with a shawl. As the priest had not arrived, the Moslim went off with the bundle and deposited it in the house of a man who was one of the water-carriers of the village, asking him to keep it till he should call again. Having thus placed his stolen goods in safety, the Moslim returned to the church.

When the service in the church was over, the funeral procession started on its way to the outskirts of the village, where a camel¹ would be waiting to carry the coffin to the cemetery.

As soon as the guilty Moslim stepped outside the church with the intention of accompanying the other mourners, he found, to his amazement, that he could not move, and that he was paralysed from head to foot; moreover, his body began to swell. He therefore called to some of his friends and begged one of them to lend him a donkey to ride home on, as he felt that he was going to die. But they all replied that they wanted their donkeys themselves, as they intended to ride to the cemetery situated some distance off near the



FIG. 3.—TREE AND BURIAL SPOT OF THE SHEIKH ABU 'AGŪR.

monastery where the interment of the dead Copt was to take place. However, when they found the terrible plight the Moslim was in, they borrowed a donkey for him, on to which he was lifted, and, some of his friends

¹ The body of a Copt is nearly always carried to the cemetery on a camel. The Copts, moreover, are buried in coffins, the body of a Moslim being wrapped in cotton or silk cloths only.

supporting him on both sides, he was in this way conveyed to his home.

Meanwhile, the parcel remained in the house of the water-carrier, who, in his turn, was troubled with terrible dreams at night, in which he saw serpents coming to bite him and his children. He suffered in this way for three nights, when he suddenly thought of the parcel which had been left at his house and had never been called for. He now decided to open it, and, on doing so, found to his amazement, that it contained the vestments of a Coptic priest. He realised that he was in a difficult position, for he did not dare return the bundle, as he feared that he would be taken for the thief; moreover, as there are three churches in this village, he would not know to which of them the vestments belonged.

In the meantime the priest of the church from which the bundle had been stolen, not knowing that the vestments had vanished, told the servant of the church to take them away and have them washed. But when the man went to fetch the bundle from the altar, he, of course, found that it had disappeared.

The Moslim, however, sent to the water-carrier and told him to take the bundle back to the church as soon as possible, telling him where to put it. But the water-carrier, instead of executing this order, went to one of the Copts in the village whom he knew, told him what had occurred, and gave him the bundle, which was then returned to the church. After this had been done the water-carrier was no longer troubled by bad dreams, but the guilty Moslim, whose whole body remained swollen, had to have one arm, which was more swollen than the rest of his body, amputated, and at the time that this story was recounted to me he was still lying very ill. It is believed that this severe punishment has been meted out to him by Saint Egladiūs el-'Azab. The events recorded above happened in 1922.

Ancient Parallels

Many of the practices to which attention has been drawn in this and the previous article find close parallels in those of the ancient Egyptians.¹

The "servant of the sheikh" may be compared with the ancient *hm-k*, "servant of the *ka*," i.e. the funerary priest, whose function it was to recite the funerary liturgy and to make periodical offerings to the deceased in the tomb-chapel to which he was attached. It will have been noted that the "servant of the sheikh" is sometimes a woman. In ancient Egypt there were female *ka*-servants, certainly in the late period,² and

¹ For the following information I am indebted to my brother, Dr. A. M. Blackman.

² See A. M. Blackman, "Priest, Priesthood (Egyptian)," in Hastings, *Encyclopædia of Religion and Ethics*, x, p. 301; *Journal of Egyptian Archaeology*, vii (1921), p. 26.

possibly even as far back as the Old Kingdom.³ Women from the earliest times could hold the position and enjoy the emoluments of a prophetship (the office of "servant of the god"; and there are good grounds for supposing that they could exercise actual sacerdotal functions in the temple.⁴

The office of *ka*-servant seems regularly to have descended from father to children,⁵ though it could be bought and sold⁶ like an advowson. Zefaihap, the great Middle Kingdom feudal lord of Asyūt, however, laid it down definitely in the contract which he drew up with the man who was to act as his *ka*-servant that, when that person died himself, the office was to devolve on his *eldest son* and not on his *sons*. This, of course, was to prevent the breaking-up of the endowments. As the tomb of a sheikh nowadays, so in ancient times the tomb of a great man was endowed with land,⁷ the income derived therefrom supplying the salary of the *ka*-servant and providing for the upkeep of the tomb and of the offerings.

The slaughtering of animals at the tomb, such a marked feature of the cult of modern Egyptian saints, was a regular feature of the ancient funerary cult. In ancient times the principal victim was an ox (though oryxes, gazelles, and geese or ducks were also employed for this purpose), and the choice part that regularly figures on the offering-table is the foreleg of beef. The foreleg in one of the funerary rites, the Opening of the Mouth, was in a special degree identified with the bleeding eye of Horus, and accordingly, still dripping with blood, was applied to the lips of the statue or mummy to imbue it with life.

It will have been observed in the former article (DISCOVERY, iv, p. 283), that one of the ritual acts incidental to a visit to a sheikh's tomb is the ceremonial sweeping of the floor. In ancient Egypt at the close both of the temple and the funerary liturgy, the priest, before leaving the sanctuary or tomb-chapel, regularly swept the floor with a besom made of twigs, or with a cloth, in order to "remove the foot (prints)."⁸

In the former article (op. cit., p. 284), mention is made of the "ferry-boat" hung up in a sheikh's tomb. This custom may be compared with the ancient Egyptian custom, which was in vogue from the Sixth Dynasty onwards, of placing model boats along with

³ Loc. cit.

⁴ A. M. Blackman, *Journal of Egyptian Archaeology*, vii, pp. 25 ff.

⁵ See Breasted, *Ancient Records*, i, ss. 200 ff.

⁶ See A. M. Blackman, "Priest, Priesthood (Egyptian)," in Hastings, *Encyclopædia of Religion and Ethics*, x, 300.

⁷ See Breasted, loc. cit.

⁸ See A. M. Blackman, *Rock Tombs of Meir*, iv, p. 50 with note 1, where full references are given.

the coffin in the burial-chamber.¹ The purpose of these boats in general was evidently just to enable the deceased to voyage up and down the Nile. But included among them there is sometimes one with a model mummy on board, its purpose apparently being to enable the deceased to enjoy the advantages procured by a voyage to the sacred city of Abydos.² Thither every pious Egyptian hoped to go at death and there be admitted into the blessed company of Osiris and his worshippers. A rarer type of boat found in tombs is a model of the sun-god's celestial barque.³ This was probably regarded as a means whereby the deceased would be enabled to traverse the heavens either in the company, or actually in the capacity, of the sun-god himself.

As has been pointed out, the burning of candles figures prominently in the cult of modern Egyptian saints. Candles were also burned in the ancient tomb-chapels on the occasions of certain festivals. They were likewise burned before the statues of divinities in temples⁴; indeed, the burning of a candle was apparently regarded as the most usual and cheapest offering that could be made to a divinity.⁵

The association of a saint with a tree or trees seems certainly to be a survival from the past, for the god Osiris was closely associated with a tree (see Fig. 1) or grove of trees. Thus Isis was supposed to pay a weekly visit to the Holy Place of Osiris on the island of Bîgeh and pour out libations to the *ivy*-tree, overshadowing the burial-place of Osiris, and also to the *mnl*-grove, on the branches of which rested that god's *bai*, or manifestation.⁶ The famous sepulchre of Osiris at Abydos likewise possessed its grove of trees, and, according to a demotic papyrus in the Berlin Museum, water was poured out in libation to Osiris on 365 altars set up under "the great trees" of the grove.⁷

Lastly, with regard to the healing powers with which modern Egyptian saints are credited, it might be pointed out that in ancient Egypt certain statues of divinities were supposed to possess special efficacy for the healing of sick persons.⁸

¹ See J. Garstang, *The Burial Customs of Ancient Egypt*, pp. 56-102 (London, 1907); cf. A. Reisner, "Models of Ships and Boats" in *Catalogue Général des Antiquités Égyptiennes du Musée du Caire* (Cairo, 1913).

² See Nina de G. Davies and A. H. Gardiner, *The Tomb of Amenemhêt*, pp. 46-8.

³ See Reisner, *op. cit.*, pls. xxii, No 4949, xxiv, No. 4953.

⁴ K. Sethe, *Urkunden des ägyptischen Allertums* (Leipzig 1905-6), iv. pp. 771 foll.

⁵ See A. H. Gardiner in *Recueil de Travaux*, 40 (1923), pp. 79.

⁶ See A. M. Blackman in *Journal of Egyptian Archaeology*, iii (1916), p. 34.

⁷ H. Schäfer in *Zeitschrift für ägyptische Sprache*, 41 (1904), p. 108.

⁸ See G. Maspero, *Popular Stories of Ancient Egypt*, pp. 174-9 (London, 1915); cf. also Breasted, *A History of Egypt*, pp. 353 ff. (London, 1906).

Trans-Atlantic Wireless

By Capt. Owen Wheeler

THE Old Year closed and the New Year opened with some remarkable experiments in the relaying, for broadcasting purposes, of wireless telephony from the United States. The precise significance of these progressive tests will be examined later, but for the moment they may be subordinated to a more general discussion of the questions (1) whether the line of experiment which has hitherto been pursued in connection with wireless communication with America has been a right line, and (2) whether, assuming its continued success, any commensurately practical results will be attained.

Before approaching the first question it is expedient for several reasons to draw a sharp distinction between wireless telegraphy and wireless telephony. The former is almost entirely a commercial proposition and, looked at as a problem, it may be regarded as in a large measure solved. Wireless telegraphic communication with the United States and Canada is carried on almost continuously, and at a rate of speed necessitating the use of automatic sending and receiving gear. The services are highly systematised, and a visit to Radio House in the City, the Marconi Company's distributing centre, gives an impressive idea of the business organisation, as well as of the scientific skill, which has been brought to bear upon this particular wireless development. The time taken in despatching a wireless message from Glace Bay in Canada to Ongar in Essex—the principal Marconi receiving station—relaying it for transmission to London by land line, and despatching it from Radio House to its destination, is only a very few minutes, and the system works with singular smoothness. A noticeable feature is the fact that the whole of the complex wireless receiving gear at Ongar can be effectively supervised by the single operator on duty.

But these results are only achieved at what in a sense is wasteful expenditure. To those who read in the papers that even telephony, which needs more power for transmission and greater sensitiveness for reception than Morse telegraphy, has been heard across the Atlantic on a couple of valves, and that a British amateur transmitter, restricted to a power of 10 watts, has carried on for hours a wireless conversation with an amateur in the States, the size of the commercial wireless stations engaged in Transatlantic traffic must seem preposterous. But the difference between an occasional transmission or reception under singularly favourable conditions and the hard-and-fast requirements of a continuous commercial service is enormous. Even with the great power at their

disposal the existing stations sometimes find communication extremely difficult, if not impossible, and it must be remembered that they have to compete with a cable service which is comparatively free from damaging interruptions. From the fact that for some little time past the Transatlantic Wireless system has remained more or less stabilised it may be inferred that no serious modifications in it are likely to be introduced as the immediate result of recent experiments.

The Promise of the Future

Perhaps the most likely advances will be in connection with aërials, filtering devices, and directional transmission with the aid of a wireless "reflector," but in all these directions experimental work has been, and is, going on quite independently of the much-talked-of tests. It will be both interesting and satisfactory if the low aerial, a mile or two or more in length, which has found some favour in America, eventually ousts the sky-scraping variety for long-distance work, for the very high mast has some serious drawbacks notwithstanding the great ingenuity displayed in its latter-day erection. The filtering out of atmospherics has already been carried to a high level of success, more particularly, perhaps, at Ongar, where it is an extremely instructive experience to listen, first to an unfiltered, and then to a filtered transmission, the former being painfully blurred by queer noises, the latter, much weaker, of course, but of perfect clarity, enabling almost any degree of subsequent amplification to be obtained. But the process is complicated, and presumably costly, and some simpler and more economical method of crushing out or intercepting the troublesome X, as the atmospheric is professionally called, would be heartily welcomed. With the "wireless beam," which will both help to lessen the effects of atmospherics and other interruptions and provide a reasonable degree of secrecy of intercourse, Senatore Marconi is busy experimenting, and is understood to have attained some highly promising results.

From the above brief statement it will appear that in the matter of radio-telegraphic communication with America progress is being made, perhaps not at any rapid rate, but in a quiet and orderly fashion, and is not likely at present—as far as can be seen—to be deflected by any epoch-making new departures. When we turn to the contemplation of the situation and prospects as regards Transatlantic wireless telephony we find different conditions, one of which is the circumstance that the transmission of speech and music across the 3,000-mile gap in question is of itself a very recent development. But it may fairly be said that here, as in the case of radio-telegraphy, the line of experiment

that is being taken is the right one, notwithstanding incidental efforts to obscure real issues, and to attach undue importance to somewhat meaningless performances. What has been done has been done progressively, with the result that a certain continuity of achievement has been realised, and something in the nature of a cumulative effect is beginning to be observable.

In this process amateurs have played an honourable part, at any rate as regards the earlier stages in which accurate records of reception under varying conditions were of importance. But latterly, and more particularly in connection with the relaying of received signals for the purpose of broadcasting them over great areas of this country or of America, the amateur, even in such a collective capacity as is represented by the Radio Society of Great Britain or the Manchester Wireless Society, has had to give place to big professional organisations. Of the work done by the London station of the British Broadcasting Company in December 1923, and by the Experimental and Research Section of the Metropolitan-Vickers Electrical Company in January 1924, it is, in some respects, premature to speak. But it may usefully be remarked that, far from overlapping, as some may have supposed it did, this work has been on distinctly separate lines, although in both cases the same station—that of the Westinghouse Company at Pittsburg with the well-known call-sign, K D K A—was received. What the B.B.C., through the agency of their very able chief engineer, Capt. Eckersley, did was to demonstrate the possibility of picking up, without any premeditated arrangement, an American broadcasting station, filtering to some extent the received speech and music, and relaying it, first to London, and then to the other seven B.B.C., so that listeners in Aberdeen, Glasgow and the rest could actually hear America on a crystal set. This was an amazing performance of great historic interest, but essentially a *tour de force*, the repetition of which on any given night could not possibly under existing conditions be guaranteed.

The Trafford Park experimental station has tried to carry the relaying of American telephony a step further by rendering it less dependent upon favourable conditions, and for this a pre-arrangement with the transmitting station was necessary. It may be suggested that the latter is in effect a retrograde movement, but in practice it is far more likely to be the only means of making any real advance. For it is reasonably safe to say that any hope of being able to pick up systematically an American station engaged simply in broadcasting its ordinary programme to American listeners is quite fantastic. By making special arrangements for directional transmission it may be possible to ensure a fair measure of success

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for a particular transmission, or series of transmissions, and this is probably the limit of actual requirement.

The Value of Trans-Atlantic Wireless

When we come to ask the second of the two questions put at the beginning of this article, namely, whether, assuming the success of such experiments as those under review, any practical results commensurate with the cost and trouble of those experiments will be attained, we find ourselves at once in the presence of some awkward facts. The first is the difference between Greenwich and Eastern Standard Time—five hours—and the second, an allied consideration, is the extreme difficulty of hearing telephony from America unless there is night on the whole breadth of the Atlantic. As regards ordinary broadcasting in the United States, it may quite truly, if not very politely, be said that the average programme sent out in the United States between 7 p.m. and 11 p.m. Eastern Standard Time, is certainly not worth the trouble of sitting up from midnight to 4 a.m. in order to listen to it. Consequently the ability to receive these performances and relay them so that they can be broadcast simultaneously throughout the British Isles is, practically speaking, a thing of very little account, or will be as soon as the novelty has worn off.

On the other hand, there is unquestionably something arresting in the possibility of broadcasting on one side of the Atlantic a special transmission from the other side of, for instance, some historic speech or more than ordinarily moving ceremony, and it is well that the facilities for accomplishing this should be explored and regulated so that, when occasion arises, they can be turned to good account. To this end the particular tests carried out between the Trafford Park Experimental Station and the Westinghouse Station at Pittsburgh have a distinct practical significance, and may lead to some remarkable developments. In passing, the Pittsburg station is particularly well adapted for such exceptional transmissions as it works habitually on a very low wave-length—only 100 metres—and consequently its messages are much less liable to interruptions from other transmitters than the great majority of American and British stations at present engaged in sending telephony. There is also said to be increased freedom from atmospherics at this low wave-length, and certain counterbalancing drawbacks in the matter of ease of reception can be overcome by special precautions.

This survey of the present state of Transatlantic wireless—necessarily brief and incomplete—may close with the advice to regard as wholly visionary—at any rate under such conditions as exist or can reasonably be anticipated—the practicability of any general personal intercourse by wireless between British and

American amateurs. Commercially there are possibilities in that direction, the Atlantic being bridged by wireless and the remainder of the connection being effected by land-line telephone. But the ether is already so greatly congested, and the available bands of wave-lengths are being so rapidly absorbed, that even this restricted advance would probably need to be very carefully regulated.

The Peace Negotiations of Prince Sixte de Bourbon—II

By R. B. Mowat

Fellow of Corpus Christi College, Oxford

Two Premiers : Mr. Lloyd George and M. Clemenceau

ALTHOUGH the President, M. Poincaré, still hoped that something might result from the Austrian peace-offer of March 24, 1917, M. Ribot, the Premier, had made up his mind that it would lead to nothing. The omission of the Emperor Charles to make a definite offer to Italy, and the refusal of Baron Sonnino to consider anything less than the whole Italian claim, were alike, in M. Ribot's eyes, fatal to the Austrian plans. Perhaps correct in these views, M. Ribot was certainly wrong in doubting, as he did, the good faith of the Austrian Emperor (speech in the *Chambre des Députés*, May 22, 1917). Charles was perfectly sincere in his intentions, and acted throughout the whole affair as an honourable gentleman. Mr. Lloyd George held this view, and even after the French refusal of April 22, he encouraged Prince Sixte not to drop the negotiations. The French Foreign Office likewise, through M. Jules Cambon, encouraged the Prince to continue, and gave him every facility.

Accordingly Prince Sixte wrote another letter to the Emperor Charles, explaining that the Austrian peace-offer had failed because it was defective with regard to Italy. On April 25 he met Count Erdödy at Zug, explained the situation to him, and handed him the letter. On May 4 Erdödy returned to Switzerland and met Prince Sixte, this time at Neuchâtel. He brought a reply which was, to a certain extent, satisfactory, from the Emperor Charles. Charles said definitely that he would make a separate peace, whether Germany liked it or not. With regard to Italy he was ready to make concessions, but not so great as were asked for.

The Second Visit to Vienna

The Prince then resolved to pay a second visit to Vienna in war-time. He left Neuchâtel at once (May 5) with Count Erdödy, crossed the Swiss frontier on the 6th, and arrived in Vienna on the 7th. On the 8th he met the Emperor at Laxenburg.

Prince Sixte and the Emperor discussed the Italian question. Austria could cede the Trentino, but only in return for compensation. Prussian (formerly Austrian) Silesia was suggested; but Charles said that he could not consent to be paid at the expense of his ally. An Italian colony was suggested, such as Erythrea—a possession of no great value to Italy, as Prince Sixte knew, for he had been to Erythrea; he seems to have been everywhere.

The result of this second visit of Prince Sixte to Vienna was that he brought away another autograph letter (the second) from the Emperor Charles, envisaging the possibility of ceding the Trentino to Italy; and a covering letter from Count Czernin with regard to compensation, ending with a statement that Austria was prepared to make a separate peace (May 9, 1917). The Emperor asked that the regular diplomatists should formally take up the task of settling the preliminary terms of peace, in Switzerland, about the middle of June. Such was the news which Prince Sixte was able to take back to the French President in the last weeks of May.

On May 20 Prince Sixte had an interview with M. Poincaré at the Élysée Palace. This time M. Ribot was present, "tired, old, with yellow glasses which he is always taking off and on—sees all the difficulties of things and only the difficulties." The President, however, was still favourable to the continuance of the negotiations, though he thought that it would be difficult to induce the Italians to surrender a colony in return for the Trentino.

At the close of the interview with M. Poincaré, Prince Sixte said that he would be happy to receive a reply in due course to the Emperor's letter. He would also pay a visit to Mr. Lloyd George, with the object of asking for a reply from England.

The British Attitude

On May 22 Prince Sixte crossed over to London. Everybody was busy in those days, and things had to be done quickly. At 11.45 on the morning of the 23rd the Prince received a message from the French Embassy, asking him to be there at 11.50. After receiving some information from M. Cambon and preparing his papers, Prince Sixte went on to Number 10 Downing Street. "The house in which for three hundred years the English Government has lodged its Premier is *assez petite*," wrote the Prince in his report. Mr. Davis, the Prime Minister's chief secretary, introduced him into

Mr. Lloyd George's study, where he waited two minutes. The Prime Minister then came into the room, and asked to see the Emperor's last letter: when he came to the passage concerning Italy, he shook his head; the offer was scarcely sufficient. As for the Emperor's idea of sending a regular diplomatist to negotiate preliminaries of peace in due form in Switzerland, he thought very little of it. "The diplomats are only made for losing time," he said: "we will only lose time by sending men who cannot speak in the name of their countries." He wanted the responsible ministers to go: why could not M. Ribot and himself meet Czernin? Prince Sixte, in view of M. Ribot's attitude, thought this impossible.

The interview terminated, and the Prince went off to a hasty lunch. At 2.45 he was back at Number 10 Downing Street, from which the Prime Minister was going to take him to see the King. Mr. Lloyd George appeared in frock-coat and tall hat. The Prince and the Premier then set off in a motor-car for Buckingham Palace. Nothing has been reported about the audience with the King, whom Mr. Lloyd George had from the start kept informed of the Austrian negotiation. The French had confidence in King George: "an excellent man, honest and straight" (those were M. Paul Cambon's words).

Mr. Lloyd George's plan was that the French and British Prime Ministers and the King of Italy should meet somewhere on the French front, and arrange a common basis of peace with Austria. The Prince was to see the Prime Minister once more, to hear his views. Meanwhile Sixte went to Ryde in the Isle of Wight for a few days' rest. He returned to London on May 30, in time to go to lunch at 10 Downing Street. The company was practically the War Cabinet: Lord Stamfordham, "small white moustache, speaking little"; Mr. Bonar Law, in a blue suit, "very simple and good-natured"; Lord Curzon, "*très lord*," but "very sympathetic, talking well and fond of historical reminiscences"; Sir Edward Carson, "very large, a rather suffering face, meditative." Lord Reading was also present. The conversation at lunch was always pleasant and interesting: "one felt that one was among well-bred people." Mr. Bonar Law seemed to be the only person who was familiar with the careers of the various French ministers. After lunch, Mr. Lloyd George talked to Prince Sixte apart for a few minutes, and said that he was expecting every day that the King of Italy would come to a conference of the Allies (M. Sonnino, of course, would be present with his sovereign). It would be found, he said, that King Victor Emmanuel would not be intransigent. "The King has different ideas from M. Sonnino. You will see we shall get something done with the King"; and, shaking his hand, Mr. Lloyd George repeated:

"M. Sonnino is violent, too violent." He asked the Prince to wait another day in London, to hear the reply of Italy. The reply came, sent (naturally) through the office of Baron Sonnino. Curious to say, the reply was evasive. Mr. Lloyd George sent off a special courier to Italy to get a definite answer, and again asked Prince Sixte to wait a few days. But the Italian Government would not fix a precise date for a meeting. Sonnino would not move. "That inflexible man does not wish to come," said Mr. Lloyd George. "Evidently he divines something" (*Évidemment, il flaire quelque chose*). So Prince Sixte had to leave London, as he had left Paris, without any message to convey to the Emperor Charles in answer to the Austrian Emperor's last letter. But Mr. Lloyd George promised to let him know as soon as the meeting of the French and English Premiers and the King of Italy was arranged. That meeting, however, never took place while the Austrian peace-offer was open; and no reply was ever given to the Emperor's letter of May 9. The Prince left London on June 5, 1917, for the Belgian front and resumed his duties in the artillery until the end of the war. The negotiations of Prince Sixte were at an end, and his only anxiety about them now was that the Emperor Charles's confidence should be respected.

Later Peace Negotiations

On September 9, 1917, M. Ribot's Government fell, and was succeeded by a Ministry, destined to endure for only two months, under M. Painlevé. The new Premier knew nothing about the Sixte dossier, which reposed behind the handsome, silent walls of the *Ministère des Affaires étrangères* on the Quai d'Orsay. On November 13 (1917) M. Painlevé resigned, and the new celebrated Ministry of M. Clemenceau began. M. Clemenceau, like the preceding Premier, was totally ignorant about the negotiations of Prince Sixte. The Emperor Charles's confidence was being scrupulously respected.

It happened that when M. Clemenceau came into office in November 1917 a semi-official peace negotiation was actually going on between France and Austria. This was quite independent of the affair of Prince Sixte, which was to all intents and purposes dead and buried. The new negotiation was due to the initiative of Count Czernin, who was making use of Count Revertera, a professional Austrian diplomatist, on the retired list. Revertera had a friend in Paris, the Count Armand, who belonged to the second bureau of the French General Staff. Revertera and Armand met in Switzerland on August 7 and again on August 22 (1917). It was a curious kind of negotiation, carried on by the French War Office, with Notes drafted under the direction of Foch and his military

colleagues. The Foreign Offices of France, Great Britain, and Italy were in touch with the affair, although not actually conducting it. In any case, the Revertera-Armand affair came to nothing because the Austrian Government still refused to cede Trieste unreservedly. The negotiation was not, however, quite finished by the time M. Clemenceau became Premier; and on November 16, when informed of the matter, he said, or rather wrote, in his laconic style: *listen, say nothing*—for it was always worth while to hear any offer that Austria might make.

The last (and quite ineffective) Revertera-Armand conversation took place at Fribourg in the Swiss canton of that name on February 25, 1918. Less than a month afterwards the grand German offensive began (March 21). The military attack, which was at first brilliantly successful, could be assisted by a political attack. M. Clemenceau was the key-stone of the arch of France's war-government now. If he could be made to fall, the *moral* of the French people might break too. Such, at any rate, appears to have been Count Czernin's idea. In a speech to the Vienna Municipal Councillors on April 2 he stated that before the great offensive (which was now in progress) began, M. Clemenceau had asked Count Czernin if Austria would enter into negotiations for peace on condition of France getting Alsace-Lorraine.

M. Clemenceau gets Annoyed

When M. Clemenceau, who was at the French front, heard on April 4 of the Austrian statesman's speech, he merely telephoned back to Paris in his brief, emphatic style: "Count Czernin has lied" (*le Comte Czernin a menti*).

Count Czernin was quite entitled to use every fair means to discredit his adversary; but it was neither fair nor accurate to refer to the Revertera-Armand negotiation as a French peace-offer. M. Clemenceau, who was not merely the most determined war-leader of France, but also a man of a naturally somewhat "short" temper, was furious. When Count Czernin justified, or attempted to justify, his statement by publicly disclosing the Revertera-Armand negotiation, M. Clemenceau had every reason to feel more indignant still. And it was just at this moment that he received from the French Foreign Office the account of the Prince Sixte negotiation which they had for some time been preparing for him. Here, at the very time when Count Czernin was accusing M. Clemenceau of asking for peace and then of preventing it by insisting on getting Alsace-Lorraine, the French Premier had in his hands a dossier of letters from the Emperor Charles and Count Czernin offering to make peace on the basis of the cession of Alsace-Lorraine to France.

M. Clemenceau, who did not know that secrecy

had been promised, might have replied by disclosing the Emperor Charles's offer. He did not do so, however, but he gave Count Czernin a warning that the French Government could make a disclosure of a much more damaging kind than anything which the Austrian Government had to say. M. Clemenceau reminded Count Czernin in a public Note (April 6, 1918) that "only two months before the Revertera affair" there was "another tentative of the same order by a personage of a rank much above his own." This warning ought to have been sufficient to close the mouth of the unhappy Austrian minister, even if he had not been (as he was) a diplomatist trained in the school of caution. But he still tried to throw upon France the blame of continuing the war. He replied in a public Note (April 8) to M. Clemenceau's last Note: that there had been a negotiation before the Revertera affair, but that also "had equally come to no result"—tacitly suggesting that here too only France's obstinacy in demanding Alsace-Lorraine had prevented peace. This, at any rate, was how M. Clemenceau understood Count Czernin's Note, and it was too much for him to bear. He replied by a public Note (April 9):

It is indeed the Emperor Charles who in a letter of the month of March 1917, with his own hand, gave his adherence to the *just French claims relative to Alsace-Lorraine*. A second Imperial letter states that the Emperor was in accord with his minister.

Prince Sixte's Negotiations become Public

By this time M. Clemenceau had been informed by the President, M. Poincaré, of the promise to keep the Emperor's offer secret. But he held that Count Czernin's conduct released the French Government from that promise. M. Clemenceau stated his point of view to two of Prince Sixte's friends, who asked that the secret might be kept. The Premier said:

The Germans wish to get rid of me. Czernin has put himself at their service in publishing this lie. I am attacked. I find an arm; I indicate that I have it. I have the right to make use of it. I give a warning to the Emperor, and if he does not make his minister keep silence, I will use it.

A remarkable fact about the whole affair is that no copies had been kept in the Vienna Chancellery either of the Emperor's two letters or of Count Czernin's covering letter; and, perhaps more remarkable still, both the Emperor Charles and his minister had forgotten what they had actually written. Therefore, when M. Clemenceau, in the Note of April 9, stated that the Emperor and his minister had concurred in agreeing to the cession of Alsace-Lorraine, Count Czernin emphatically replied: "The absurdity of that assertion is evident. The assertions of M. Clemenceau concerning proposals made by the Emperor Charles in

a letter are lies from one end to the other" (Note of April 11). This statement inevitably brought about the publication by M. Clemenceau of the Emperor's letter to Prince Sixte of March 24, 1917.

It will be supposed that the damning publication of this letter, with its plain statement—"I will support, by all means and using all my personal influence with my allies, the just French claims relative to Alsace-Lorraine"—would be sufficient to close the controversy. But no, Count Czernin would not accept the evidence of the printed text. On April 13 he replied, with a degree of obstinacy that is almost stupefying, "The letter of His Majesty, published by the President of the Council of French Ministers, is falsified." Then he went on to give his own account of the Emperor's letter. *That letter*, he wrote, contained, relative to Alsace-Lorraine, the following passage:

I would have used all my personal influence in favour of the French pretensions and claims concerning Alsace-Lorraine, if those pretensions were just; but they are not.

There was now nothing left for M. Clemenceau to do but to publish a photograph of the Emperor's actual letter. The letter in the French Foreign Office, of which M. Clemenceau had already published the text, was only a copy. It was no good to publish a photograph of that. The inference to be drawn from Count Czernin's last statement was that the Emperor's letter of March 24 as written to Prince Sixte had been deliberately falsified by the Prince, who had then allowed the French Foreign Office to take a copy of the letter as falsified. This suggestion could easily be disproved if the original letter, which was in the possession of Prince Sixte, could be produced. But Prince Sixte was away on sick-leave, recuperating in Morocco; and conscious of his own good faith and at the same time deeply regretful of the necessity of the disclosure already made of his brother-in-law's confidence, he refused to move. In answer to M. Clemenceau's telegraphed explanation of his already having published the copy of the letter, he replied: "I bow before the necessity which you invoke, although that sacrifice, which I accept for the sake of France, is particularly painful to me, since I had given my word of honour and received that of the French Government that the letter of the Emperor Charles would not be, in any case, divulged."

But the Emperor Charles, who was a thorough gentleman, would not leave his brother-in-law under Czernin's mean insinuation of forgery. Charles had forgotten what he had written, but he did not allow this fact to overcome his sense of justice: on April 13 he made Count Czernin publish a Note stating: "The character of Prince Sixte de Bourbon, which is well

known to the Emperor, excludes all possibility of falsification. Neither he nor any other personality has been yet accused of it." On the same day Count Czernin resigned.

It was not until the war was all over, and the Emperor Charles no longer a ruler, that Prince Sixte, now that no harm could be done, allowed the Emperor's letters of 1917, both that of March 24 and that of May 9, to be photographed and published.¹

Modern Industries—IX

Radium Extraction in Cornwall

By Edward Cahen, A.R.C.Sc., F.C.S.

WHEN one considers that radium itself was only discovered in 1898, only twenty-five years ago, the extraction of this element from the ores on a commercial scale may indeed be considered a modern industry. This is not the first time that radium has been worked in Cornwall, for some years ago the late Sir William Ramsay was concerned in a company formed for this purpose in the neighbourhood of St. Ives.

To-day it is a French Company, the Société Industrielle du Radium, Ltd., which is responsible for the works where this precious material is being recovered. It is owing to the courtesy of the directors of this company and their Chief Chemist, Monsieur Pochen, that I am able to give readers of DISCOVERY this short account of what is actually being accomplished in this the youngest of all industries. They have also been kind enough to lend me the photographs with which the article is illustrated.

Beautifully situated on the slope of a hill above a secluded valley not very far from the county road to Newquay, an orderly little works is to be found by the curious; the mine-shaft on the top of the hill with its usual winding gear standing out boldly against the sky (Fig. 1) and the buildings in which the various processes take place nestling in the valley below. This mine with its euphonious name, South Terras, is situated quite close to Grampond Road Station on the Great Western main line.

¹ The whole affair is very fully related with documents in *L'Offre de Paix Séparée de l'Autriche* (Paris, Plon-Nourrit) written by M. de Manténayer, one of the friends of Prince Sixte who assisted him in the negotiations. The English translation, with the title *Austria's Peace Offer, 1916-1917*, is published by Messrs. Constable & Co. The work contains photographic reproductions of the Emperor Charles's autograph letters of March 24 and May 9, 1917, and also of the autograph letter of Count Czernin, May 9. This last letter was not alluded to by M. Clemenceau in his revelations of April 1917, because the copy of it, which had been deposited in the *Ministère des Affaires étrangères* could not be found.

In the largest of these buildings in the valley may be seen what is really a laboratory experiment carried out on a large scale, where tons of ore are dealt with in place of a few grammes, for the extraction of radium from its ores is essentially a chemical process. It is a significant fact that radium always exists in its ores in a definite proportion to the metal uranium from which it was derived; for every ton of uranium (element) present there are only 320 milligrams of radium (element). It will be appreciated therefore that a large quantity of ore has to be treated before a milligram of radium is obtained. To be precise, only five and a half milligrams of radium are obtained from every ton of ore treated at South Terras.

Sources of Radium

Radium is generally derived from pitchblende, and though there exists a lode of this ore from 2 in. to 14 in. wide in the mine, at the moment it has not been drawn upon at all. The material which has hitherto been worked comes from those portions of the mine near the surface, down to some 20 fathoms in depth, and consists of killas and granite in which are embedded shining green plates of a mineral called torbenite. This is a phosphate of the metals uranium and copper containing radium in the proportion indicated below. Below this, at the bottom of the mine, is the lode of black pitchblende, which, it is hoped, will be worked during the present year.

The ore is brought to the surface, trammed to the drying and crushing plant situated a little lower on the side of the hill, and then passes on to the extraction plant situated lower still. This is all contained under one roof, the plant being so designed on the slope of the hill that the solutions obtained may be conveniently siphoned off from their insoluble residues. In this way, as the ore undergoes the various stages of the process, the waste, or perhaps one should call them the by-products, are eliminated one by one until we are left with the radium associated with barium at the lowest level of all.

The ore, containing, as it does, both copper and uranium, yields solutions of the most beautiful green colour, especially as the uranium salts have a yellow-green fluorescence. The solutions look very attractive in the great white concrete pans seen in the illustration (Fig. 2).

The Extraction Process

Formerly the ore was boiled with commercial hydrochloric acid, but the overhead charges for carriage combined with a drop in the price of the finished product made it necessary to seek a cheaper process. Accordingly a paste is now made with cold commercial hydrochloric acid which is left for some three weeks,

when most of the metals are found to have dissolved. The radium is found entirely in the "slimes." The paste is washed with water in a hydraulic classifier to



FIG. 1.—THE TOP OF THE HILL, WITH THE WINDING GEAR AND TRAMLINES.

separate the radioactive "slimes" from the sands, which contain no radium at all. The "slimes" and the solution of the other metals are run into a vat and there allowed to settle. When the liquid above the "slimes" is seen to be clear it is siphoned off and treated with excess of carbonate of soda. This precipitates the metals other than uranium as carbonates, and they are thus eliminated. The bright yellowish-green solution containing the uranium is first carefully neutralised with sulphuric acid and then precipitated with caustic soda. In this way the most important by-product in the process, uranate of soda ($\text{Na}_2\text{U}_2\text{O}_7$), is obtained. This contains about 70 per cent. of uranium oxide (O_3O_8), and is sold to Germany, where it is refined and eventually disposed of to the glass factories. It is used to produce that peculiar fluorescent yellowish-green glass. Some 4,000 lb. were disposed of in this way during the past year.

Having thus successfully disposed of the uranium in fact as well as on paper, we must return to the "slimes" containing the radium. These, after mixing with barium chloride and boiling with carbonate of soda, are run into concrete tanks (Fig. 2), where they are allowed to settle. The radium is still in the sediment; the liquid above it, which is unused carbonate of soda, is siphoned off and utilised in the uranium extraction process which has just been described.

The sediment is washed with water to get rid of any sulphate of sodium and then boiled with commercial hydrochloric acid, which has been previously freed from sulphate by boiling with barium chloride.

The solution is again allowed to settle and siphoned off when clear. The residue this time contains no radium, which has gone into solution as the chloride.

We are now approaching the final stages of this long process of elimination and are left with a clear solution of radium and barium, to which sulphuric acid is added, which throws the barium and the radium out of solution as a heavy white powder. This rapidly sinks to the bottom and allows the liquid to be siphoned away. The heavy white powder, composed of the sulphates of barium and radium, is then boiled with carbonate of soda and so converted into their carbonates. The sodium sulphate is washed away with water, and the process of boiling with hydrochloric acid, freed from sulphate, is again repeated. The chlorides of radium and barium obtained are this time very much purer than they were after the first treatment.

The mixed chlorides are now subjected to a process known as fractionalisation, the object of which is to gradually remove the barium. Finally the chlorides are converted into bromides and again submitted to this process of fractionalisation, until at long last radium bromide is obtained free from barium and ready for the market. By now it should be abundantly clear to the reader, if he has followed the fortunes of the radium through the intricacies of the various chemical processes which have been outlined,

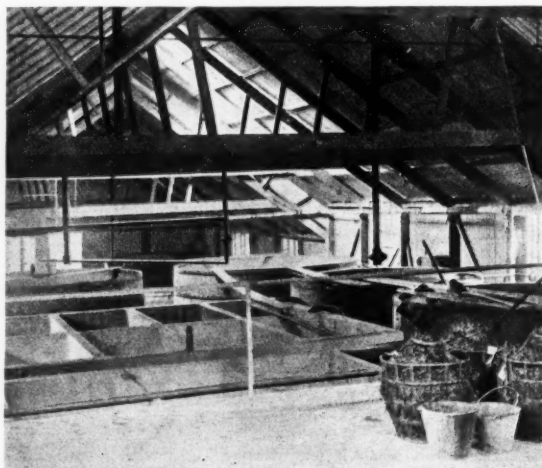


FIG. 2.—THE INTERIOR OF PROCESS BUILDING.

The vats in the background are used for the precipitation of the radium and barium as sulphates. Those on the right of the picture are used for receiving the slime when it leaves the classifier. The concrete tanks in the centres are used for washing the "slimes" after they have been boiled with carbonate of soda.

why it is that radium is such a costly luxury. Radium bromide is to-day worth about £8 per milligram, and some 700 milligrams have been produced at South Terras to date.

Testing for Radium

It may be asked how the chemist in charge of the process knows whether a solution or a residue, as the case may be, contains radium or is free from this element. For this purpose he has a most ingenious little instrument called an X-ray electroscope. Essentially this consists of two leaves of gold, such as gilders use, suspended in a metal box through the side of which there is a little window and a microscope through which their behaviour can be watched. Before a sample is to be tested the gold leaves are charged with electricity, when they stand out wide apart. If the sample introduced into the instrument contains much radium, the leaves will collapse immediately. Furthermore, by observing the rate at which they collapse and comparing it with known quantities of radium, a very fair idea of the amount of radium in the sample may be formed. A sample free from radium of course does not disturb the leaves at all.

Notes of the Month

ASTRONOMY

Rediscovery of a Famous Comet

ON November 10 last Mr. Reid, observing at Cape Town, discovered a fairly large but very faint comet, with no definite nucleus, resembling a faint star-cluster. It was not until December 1 that the comet was reobserved at the Cape Observatory. It was then very faint, of the twelfth or thirteenth stellar magnitude. The discovery, however, is of considerable interest, for the comet has been identified as D'Arrest's periodic comet, which was not observed at its last return to the Earth's vicinity in 1917. The comet was first discovered by D'Arrest at Leipzig on June 27, 1851. Within a fortnight of its discovery, observations of its path through the sky clearly indicated elliptical motion. A period of over six years was assigned to the comet, which was rediscovered in the winter of 1857-8 by Maclear at the Cape. Owing to its unfavourable position, the comet escaped notice in 1864, but was rediscovered in 1870. On some of its recent returns it has not been observed. Its rediscovery indicates that it is still in existence, though its extreme faintness would indicate that, like other short-period comets, it is becoming less conspicuous with the passage of time.

Stationary Clouds in Space

At a recent meeting of the Royal Astronomical Society a highly important communication was read from Dr. J. D. Plaskett, the distinguished Canadian astronomer, and his paper, "The H and K lines of Calcium in O-type Stars," is printed in *Monthly Notices*, vol. lxxxiv, No. 2. The anomalous behaviour of the H and K lines—the calcium lines—in the spectra of the B-type stars has long been familiar to astronomers. These lines do not

share the Doppler effect due to the radial motions of these stars. Dr. Plaskett has now demonstrated that these stationary lines are not confined to the B stars. They are prominent in the spectra of the O-type stars, and in the O-type stars with bright lines known as the Wolf-Rayet stars. "It was previously supposed," says Dr. Plaskett, "that the stationary H and K were confined to spectroscopic binaries, but they are always present in the O-type stars, whether of variable or constant velocity."

Dr. Plaskett gives an admirable summary of the evidence now available. "The H and K lines," he says, "persist, as uniformly strong, sharp, and narrow lines, constant or nearly constant in position, through four subdivisions of the B-type—B₃ to B₀—and in practically every example of all. Five divisions of the O-type—O₉ to O₅. What is still more striking, the H and K lines with similar characteristics are superposed on the emission bands and on the continuous spectrum of the three Harvard subdivisions O_a, O_b, O_c of the Wolf-Rayet stars, none of which show a trace of any other absorption." Dr. Plaskett also remarks that a spectrum of the planetary nebula N.G.C. 2392 shows the H and K lines sharply in the nucleus, while they appear also in some stages in the development of the spectra of temporary stars. "It seems hardly possible," he concludes, "to suppose that these lines, and these only, should remain constant in character over so wide a range of celestial objects, in which the other lines are appearing, changing in character and position, and disappearing in the most bewildering way, unless they are due to some common origin and are produced in some uniform way independent of the widely different conditions prevalent over such a wide range of spectral types." An examination of the velocities indicates clearly that these lines are extra-stellar in origin. Speaking generally, the various velocities derived from these lines differ only slightly from one another and from the solar component of the radial motion, while the stellar velocities, derived from other lines, show no relation to the motion of the Solar System.

The German astronomer, Dr. Hartmann, who first drew attention to the curious behaviour of the lines, put forward as a tentative explanation the existence of interstellar clouds of calcium vapour between the Solar System and the stars in whose spectra the lines were visible. An alternative theory was to the effect that such stars have outer envelopes which do not share the stars' motions. Dr. Plaskett adopts, and develops with modifications, the first theory. The matter which gives rise to these absorption lines, however, would appear to be distributed not into isolated clouds which happen, in a large number of cases, to lie between the Sun and the stars, but to be of fairly general distribution extending over wide areas in the sky. While the evidence relates to regions in and near the Galaxy, there is no reason to believe it to be confined to the galactic regions. This wide distribution indicates that the matter is of extreme tenuity. "In addition, the velocity evidence shows that it must be nearly stationary with respect to the local

stellar system." According to a suggestion made by Mr. H. H. Plaskett, Dr. Plaskett's son, "radiation from the very high temperature stars, to which the phenomenon is confined, should readily ionize sufficient calcium in the neighbourhood to give the H and K lines—sharp and narrow by reason of the low density of the cloud—while the same cause would equally well explain the sodium lines." We are reminded of the recent work of Dr. Hubble on the luminosity of the nebulae. His conclusions as to the wide prevalence of dark nebulous matter, portions of which are excited to luminosity by the radiation of bright stars, is confirmed by Dr. Plaskett's work, and further support is given to Professor Russell's suggestions concerning the origin of the dark clouds from radiation pressure.

In the discussion of Dr. Plaskett's paper at the Royal Astronomical Society meeting, Professor Turner pointed out that "we have here a hint of a method for giving the absolute motion of the Solar System from the existence of cosmical clouds at rest."

A Cluster a Million Light-years Away

Dr. Shapley has announced that it is now possible to estimate the distance of a remarkable group of stars and nebulae known as N.G.C. 6822, discovered by the late Professor Barnard about forty years ago. Few, if any, of the stars in this group are brighter than the eighteenth magnitude. Applying his well-known methods of measurement, Dr. Shapley finds that the distance is of the order of a million light-years. As a light-year is approximately six billion miles, the distance of this distant object would work out as approximately six million billion miles, the greatest distance yet measured or estimated. According to Dr. Shapley, it is "probably quite beyond the limits of the galactic system."

The Magellanic Clouds

Professor Shapley states that a photograph in the Harvard collection, taken by Professor Bailey as long ago as 1909, permits an improved determination of the angular dimensions of the two Magellanic Clouds. It "also shows the absence of any material linkage of the two clouds, since the fifteen degrees between their edges are seen to be quite free of connecting nebulosity or faint star groups." The two clouds appear to be quite independent of each other, and there is little or no suggestion of spiral structure in either, "the various condensations being irregularly distributed."

The distances which Dr. Shapley deduces from his investigation—which distances, he remarks, must be considered provisional—are 25,000 and 35,000 parsecs for the small and large clouds respectively, and the diameters 1,600 parsecs for the small cloud and 4,400 for the large. Translated into light-years, this gives over 75,000 light-years for the distance of the small cloud, and over 100,000 for the large. The diameters are approximately 5,000 and 14,000 light-years. The results of further investigations will be awaited with interest.

HECTOR MACPHERSON.

BIOLOGY

Comparatively little attention has been paid in this country to a subject which has aroused much discussion in France of late years—Portier's hypothesis of Symbiosis. At the outset, it ought to be said that, at least in its original form, it has been somewhat discredited. But it is probable that more will yet be heard of it.

Symbiosis—living together—is a phenomenon familiar enough in nature. It is well known that the root nodules of beans represent bacteria living with the plant and doing work for it in return for benefits which they get from the plant. Similarly, the lichens are really fungi and algae, or primitive green plants, living in harmony.

A parasite robs the till; symbionts take in each other's washing; that statement may serve to show the relation between these two types of fellowship in living organisms.

Portier suggested that all living creatures except the bacteria were really examples of symbiosis. He believed that man himself was composed of one animal, existing in cordial relationship with innumerable other living creatures; and that each living cell included inside it many such helpful strangers. He believed that a fresh stock of these symbionts was procured by the body through food. Hence, he said, the importance of the Vitamine, which was really a living creature. It was killed by heat, though less easily than other forms of life; it died of itself in the course of time. He even claimed to have grown the Vitamine of rice from the husk of that grain; he said that he could cultivate it on a nutrient medium as a bacteriologist cultivates a parasitic bacterium.

In China, India, and Japan rice, which forms the staple diet of millions of the people, is prepared for use by removing the husk. The disease known as Beri-Beri is common there, and it has long been believed that it is due to the lack of something present only in the husk, and this belief is born out by the experimental production of Beri-Beri in pigeons, and its cure by adding rice-husks to the diet.

As we have said, investigations showed numerous errors. But the theory in itself has much to commend it. Every year the importance of symbiosis in the mechanism of life becomes more evident. The difficulties which face the investigator of the problem are obvious. If such symbionts exist, they are mutually adapted; and it follows that it would be a matter of great difficulty, if not in fact an impossible task, to grow them apart from their partners.

Meanwhile, it is significant to note that in the blood of mammals there exist, in the white cells, organisms with an independent life; they have been grown outside the body in a suitable medium. Are we to look upon them as symbionts? Have they invaded the body from without at some period in the history of life? There is much in common between the white blood-corpuscle and the parasite that causes dysentery. Professor Nuttall has discussed these problems before the British Association, and his address will be found in *The Advancement of Science*, 1923 (John Murray), where full references are given.

R. J. V. P.

Reviews of Books

The Philosophy of Humanism and of Other Subjects. By
VISCOUNT HALDANE. (John Murray, 12s. net.)

Lord Haldane's volume stands in a rather closer relation to his *Reign of Relativity* than its somewhat evasive title would seem to suggest. It is really an elaborate appendix, or series of appendices, with no very marked unity of its own, and can hardly be profitably studied by readers not familiar with the former volume. First come three chapters on Humanism, of which Literature, Music, Art, and Religion are taken as typical; next three chapters on Mathematical Physics, containing further reflections on the Einstein theory and allied speculations; the seventh chapter, entitled Biology, is an essay in exposition and defence of the neo-vitalism of which Lord Haldane's distinguished brother, Dr. J. S. Haldane, is the most eminent champion in the field of physiology; and the eighth chapter considers the modern developments of psychology (McDougall's physiological psychology, psycho-analysis, behaviourism) in their philosophical significance. The whole is prefaced by a survey of the present state of philosophy, and the "Concluding Remarks" reaffirm the writer's general position with the aid of an adverse criticism of the conception of philosophy implied in Mr. Bertrand Russell's *Analysis of Mind*.

Success in reducing this mass of heterogeneous material to a real unity would be a feat almost without parallel; and it may be said at once that Lord Haldane has not performed it. The volume is very composite in character, and reads as if its parts had been written at different times and for different purposes. Neither Humanism nor any of the "other subjects" is examined in sufficient detail to throw more than a very vague and doubtful light on the writer's philosophical position. But a reviewer must seek the One in the Many. We therefore select three points which seem to be of "foundational" (if we may borrow Lord Haldane's favourite adjective) importance to the philosophy expounded. These are—(1) the Concrete Universal; (2) the constructive activity of mind; (3) the conception of "standpoint" in knowledge. In regard to each of these main points we complain of a serious lack of precise statement.

(1) *The Concrete Universal*.—Lord Haldane maintains that this is the "object in every kind of knowledge," "an unambiguous and unique fact of an individual character." The most particular experience partakes of a universal character, apart from which experience is impossible. And, on the other hand, "we never really think in purely general abstractions. We always form images which are symbolic of possible particular cases included, but indicate a class determined by general predicates with which our immediate purposes are concerned. The dynamic character of thought causes us to do this" (p. 58). Thus the presence of symbols or images in abstract thinking is taken as establishing its concrete character. (This point, though repeated more than once, is never expanded.) The object of abstract thinking is forthwith, on this sole ground, covered by the same phrase, "concrete universal," as a great leader (p. 86),

an act of religious self-surrender (p. 88), or any work of art. The sole and conclusive test of a concrete universal thus appears to be the presence together of universal and particular elements, however these elements may be related. In fact, Lord Haldane's contribution to the elucidation of the "concrete universal" is reducible to the assertion that human thought in all its forms and phases envisages what is at once particular and universal.

(2) *The Constructive Activity of Mind*.—"Mind," says Lord Haldane, "is active . . . in the construction of the object in which it finds itself and only itself" (p. 85). "The actual is only actual through its relation to knowledge" (p. 241). The chief part in relation to this oft-repeated and very central dogma is played by the terms "universal" and "conception." In most passages these two terms are treated as equivalent. The universal "moments" in the object of knowledge are said to "belong to thought," in contrast with other moments which "are in the nature of vanishing particulars" (p. 230). The modern developments of science are specially welcomed as "an attempt . . . towards the interpretation in terms of universals of an actual world," and hence as a recognition of "the part which mind plays in the fashioning of our knowledge of what we call facts" (p. 170). "Modern science has progressively given to quantitative measurement a conceptual significance" (p. 201). (What other significance could it have?) "Mathematicians are trying to interpret physical phenomena in terms of universals" (p. 180). (How else could they interpret them?) "Concepts of the nature of universals enter here [i.e. in certain biological phenomena] into the constitution of individual facts" (p. 213). We are nowhere told what the concepts are (if any) which are not universals: but we are told that these various developments testify to "the conceptual character of the actual which Aristotle and Plotinus contended for" (p. 194), and to "the fashion in which concepts and laws enter into physical reality and mould it" (p. 200); and we reach the general result that "reality is not from every point of view [the qualification is obscure] separable from our knowledge of it, but is fashioned by concepts which in giving it meaning give it also existence" (p. 237). But in the absence of further information as to the precise meaning of the leading terms, the contention remains exceedingly vague.

(3) *The Conception of "Standpoint"*.—Lord Haldane's view is that each science has its own standpoint, defined and limited by certain conceptions assumed to be adequate for the explanation of the relevant aspects of reality. These assumptions are also called categories; and "into an individual phenomenon the categories of more than one of these orders may enter" (p. 29). The criticism of these root conceptions is a main task of philosophy, whose chief service in this region is "to keep reminding men of science never to forget to criticise their categories before employing them" (p. 300). It seems clear that the scientist, confined to his own field, cannot criticise his categories in the philosophic sense; but the main question on which further light is needed is the relation of these standpoints to one another. "Knowledge," we

are told, "is an entirety, and within that entirety appear many standpoints irreducible to each other which give rise to relativity in orders of appearance. The result is that reality discloses itself as varying in character" (p. 85). If this is true, it does not seem possible that any standpoint should be "adequate to the full reality," though the possibility of such seems to be elsewhere implied; and, on the other hand, it seems necessary that *all* genuine standpoints should be "irreducible to each other." Perhaps Lord Haldane means to assert that philosophy is not itself in this sense a standpoint. Certainly he meets more than one difficulty in his later chapters by suggesting, if we understand him rightly, that the philosopher is free to stand now at one point and now at another, with different results, each set valid within its limits in each case. Is it in this combination in one view of different aspects of phenomena that philosophy approximates, so far as human thinking can, to a grasp of the entirety which is knowledge? If Lord Haldane would develop this point in greater detail, he would leave the reader with a clearer grasp of the task of the sciences and of philosophy, and make possible a necessary discrimination between those limitations of scientific categories which are damaging and those which are not. For merely to show that the standpoint of a science is limited is not, it seems, on this theory, to reveal a defect, but rather to exhibit a necessary feature of a certain order of thinking, already presupposed when it is called a science.

On these three points, then, we consider that Lord Haldane's views are stated with insufficient detail and precision, and we regard this as a defect which detracts considerably from the value of the book. The defect is aggravated by an extreme lack of felicity in expression, often leaving the reader in serious doubt as to the reference of a pronoun or the meaning of a sentence. Here are two instances, chosen almost at random. "It is a world of externality in order to which we are held bound, and such an order of externality is different in its very nature from that of which the level is one at which ends and the organs which express them are indistinguishable alike in space and time" (p. 213). "Apparently he did not realise the methods in which this semblance of a breaking-up of the entirety of knowledge on the part of Kant had been sought to be got rid of by later metaphysicians" (p. 13). There are two small mistakes in a sentence quoted from Locke's *Essay* on p. 80. Lord Haldane could smooth the path of the reader a good deal by improving his English.

J. L. S.

Uses of Waste Materials. By ARTURO BRUTTINI. (Pp. 350; 94 figures; 8vo.) (Published by P. S. King & Son, 2-4 Great Smith Street, S.W., for the International Institute of Agriculture, Rome, 1923. 12s.)

Professor A. Bruttini is Librarian of the International Institute of Agriculture, and recognised as a high authority on agricultural chemistry in Italy. The book gives a valuable summary of the efforts made during the war to increase the volume of materials suitable for human food, animal feeding-stuffs, and fertilisers, by using new materials and so-called waste products. The first part

deals with the legislative and administrative methods adopted by Great Britain, France, Germany, and Italy, and to a lesser extent by other countries, for increasing available foods and feeding-stuffs through the use of substitutes.

In Part II is discussed in considerable detail the technical treatment of a great number of waste materials, especially by methods developed during the war. The section on human foods deals largely with substitutes for flour, tea, coffee, spices, and meat; with wild plants suitable for food, and also with the by-products and residues of the dairy industry. The section on feeding-stuffs contains interesting information on the forage-possibilities of vegetable and fruit residues, and of the leaves, shoots, and seeds of many common trees and wild plants. The question of using the waste products of sugar-refinery, brewery, and the like is also treated, and a valuable set of tables is added showing the composition, availability, and starch-value of the various feeds.

In the section on fertilisers the latest methods of obtaining potash from industrial residues, and also from seaweed, are described in detail. The account of the work of collecting and utilising the giant algae of the Pacific coast of the United States, as in certain commercial enterprises, will be new to many readers. Other sections bearing on questions of national economy are those on the treatment of sewage and town refuse.

The concluding section describes the manufacture, largely from fruit residues, of alcohols and of oils of all kinds, the chemical and physical characteristics of the oils being added.

This study of the values of waste materials was first published in French in 1922, and (with certain additions) in Italian in 1923. The present edition is a translation prepared from both these editions and embodies a considerable amount of new matter and some fresh illustrations.

The Physical Basis of Life

The Mechanism and Physiology of Sex Determination.

By RICHARD GOLDSCHMIDT, Director of the Kaiser Wilhelm Institute for Biology, Berlin-Duhlem; translated by W. J. DUKIN, D.Sc. (Methuen & Co., Ltd., 21s.)

The Physical Basis of Life. By EDMUND B. WILSON, Professor of Zoology in Columbia University. (Oxford University Press, 7s.)

Nutrition: the Chemistry of Life. By LAFAYETTE B. MENDEL, Sterling Professor of Physiological Chemistry, Yale University. (Oxford University Press, 14s.)

There is at least one way in which this turbulent generation has calmed down. Tyndall, in 1874, could startle the world to indignant protest by his conception of "non-living matter as offering the promise and potency of all terrestrial life." Darwin, who filled in the gap, and suggested a means whereby one single unit of life could develop until it peopled the world with living things of all imaginable variety, was met with equal opposition.

The problems offered, the difficulties involved in any argument about the nature of life, have not become less with the passage of time. They have, perhaps, passed out of the sphere of consciousness of the man in the street to the more rarefied atmosphere of the expert. But they have lost their power of evoking indignation. "Life," perhaps the majority would say, "involves more than a happy linkage of tame atoms and molecules. Somewhere there comes the overwhelming fact of consciousness"; and though Huxley might say, "The thoughts to which I am now giving utterance . . . are the expression of molecular changes," one does not feel that the statement has done much to clarify one's ideas. And so the tumult and the fighting has died; and the conflict of the laboratories no longer disturbs our peace of mind.

But these three books serve to remind us that, whatever life may be, the material means whereby it manifests itself are daily becoming more plain. Let us frankly admit that the whole mass of information about the cell, which is the structural unit of the body, and its mechanism tells us little more about life than an analysis of a violin tells us about a violinist. That statement detracts nothing from the importance of the latest researches into such subjects.

Let us take first the question of the mechanism of sex. The problem of the existence of two sexes is, as the author says, one whose solution would remove a veil from a great part of the secret of life. It is not solved. There is scarcely a single organism in the living world of which we can say with certainty that its only means of reproduction is one not involving the union of sexes; and why that should be, one cannot tell. But the problem of what it is, granted that two sexes exist, that determines the sex of the offspring is one which is, to a very great extent, solved. It is not a matter of good or bad feeding, as some have supposed; of predominant strength of mother or father; it is no accidental arrangement which decides whether a male or female child shall be born. It depends upon the fact that, in one sex, the cells which are concerned with reproduction—the spermatozoon or male cell, and the ovum or female cell—are not all alike. In the case of man, two kinds of spermatozoa are produced, and only one kind of ovum. If one kind of spermatozoon and an ovum meet, the result will be a male child; if the other, a female. And this is the striking fact—an examination under the microscope of the sex cells can distinguish a difference between the one and the other kind.

What that difference is need not concern us; the question has been discussed by Julian Huxley in a previous number of DISCOVERY. A material substance—in point of fact a little rod called a "chromosome" or "colour-body," from the ease with which it may be stained for microscopic purposes—present in one reproductive cell determines the sex of an offspring. But it determines far more. That little colour-body carries with it, we know for certain, other properties besides sex-determination. In some cases an hereditary disease such as colour-blindness is carried by it as well—such diseases are only

found in one sex. With the microscope's aid, each of us can see, with his own eyes, material bodies which we know are the cause, the conveyers, of all the characteristics of the offspring. Gilbert's verse—

"Every little boy or gal,
That's born into this world alive,
Is either a little Liberal
Or else a little Conservative,"

if we understand the two parties mentioned as put typically for all the political possibilities—expresses a psychological fact; we are born with mental tendencies. These too, seem to be handed down to us through these tiny "colour bodies," so that we are able to see, to-day, tiny strands of organised matter which later on, when the individual is evolved on the fertilisation of the egg, and further evolved, if the same term may be used, by development as a portion of the social organism, will be expressed as poetry or prose or murder or idealism—or—but imagination shrinks from a longer list!

The problem becomes too wide in its application. Enough has been said to emphasise the astonishing questions which the study of the cell—that unit of life whereof all living beings are composed—must call up. The structure of that cell deserves the most minute attention.

Professor Wilson, in his short but amply illustrated book, devotes his space to that study. There are many organised structures which can be identified through very high magnifications of the microscope, whose function is not yet known. There may be many more, intimately concerned with the mechanics of life, too minute to be seen. But the author has not confined himself to mere description. He discusses the problem of life from his particular standpoint. Finality he cannot give us; we are as yet too ignorant, and the road lies through tangled places which one can only, pathetically, call metaphysics. But he can, and does, stimulate our interest.

And finally we come to Professor Mendel and the Chemistry of Life. Here we attack the problem of life at its very basis. The life of Napoleon and the burning of a match have much in common: they are both chemical processes; the end product is the same—ashes and carbon dioxide. Professor Mendel is among the foremost workers in a fascinating field. His book, moreover, differs from the others which we have considered: they are only to be read in grim earnest, by the man who is willing to set aside some time to master the subject. *Nutrition*, however, is a book for everyone. It is admirably illustrated, by very convincing photos and diagrams.

And yet, without wishing to belittle the wonderful results of the bio-chemists, we sometimes wonder how far they have really got along their road. We have all heard of the vitamins; we know that we cannot live without fresh food; that there is something present in green vegetables that can prevent many illnesses. Captain Cook knew as much, on his journeys round the world. What is the substance necessary to life? To the bio-chemist, the answer is "A vitamin"; to Captain Cook, the answer was "A lemon." "Plus ça change, plus c'est la même chose."

To end our notice of these three important books, we can only add this advice: read them. They will repay close study; they will stimulate curiosity. At the end of that study you may not know what Life is; you will have learned at least that the little that man has discovered about it makes a story of the greatest possible interest.

R. J. V. PULVERTAFT.

Physics, Vol. I. *Mechanics, Heat and Heat Engines*. "Science for All" Series. By W. J. R. CALVERT, M.A., Science Master at Harrow School. (John Murray, 3s. 6d.)

A study of recent books intended for the instruction of beginners in the Natural Sciences gives one a strong impression of the advantages which the student of to-day possesses over his brother of only a few years ago. Every normal boy and girl wishes to know how things work. But the road to knowledge through many elementary books is intolerably dreary. This admirable series, which is under the general editorship of G. H. J. Adlam, M.A., B.Sc., strikes a refreshingly new note. Throughout this book the attention of the reader is drawn to practical applications of the theories under consideration. There is, moreover, nothing taken for granted—such as mathematical or technical knowledge. It would be possible—and, we think, most desirable—to put this book in the hands of a "classical side" student with every confidence that he could follow the argument, and that the examples would be drawn from everyday objects—such as clocks, steam engines, bridges, and other buildings. The field covered is a wide one, but a wise discretion in excluding less important or complex matter has avoided the appearance of condensation. The price of the book, 3s. 6d., deserves very favourable comment.

Books Received

Physics, Vol. I. By W. J. R. CALVERT, M.A. "Science for All" Series. (John Murray, 3s. 6d.)

Individual Psychology. By ALFRED ADLER. (Kegan Paul, 18s.)

The Theory of Relativity. By ERWIN FREUNDLICH, Director of the Einstein Tower; translated by HENRY L. BROSE, with an Introduction by VISCOUNT HALDANE. Three Lectures for Chemists. (Methuen & Co., Ltd., 5s.)

Man's Mental Evolution, Past and Future. By HENRY CAMPBELL, M.D. (Baillière, Tindall & Cox, 3s. 6d.)

The Psychology of the Atom. By H. A. LILBURNE. (Taunton Brothers.)

Education in the Factory. By R. W. FERGUSON, B.Sc., A.R.C.S. (Publication Department, Bournville Works, 6d.)

Life: An Introduction to the Study of Biology. By SIR A. E. SHIPLEY. (Cambridge University Press, 6s.)

The Sciences and the Humanities. By VICTOR BRANFORD. (Leploy House Press.)

The Physical Basis of Life. By EDMUND B. WILSON. (Yale University Press; New York: Humphrey Milford, 7s.)

Nutrition. By LAFAYETTE B. MENDEL. (Yale University Press; New York: Humphrey Milford, 7s.)

The Story of a Great Schoolmaster. Being a Plain Account of the Life of Sanderson of Oundle. By H. G. WELLS. (Chatto & Windus, 4s. 6d.)

Correspondence

NEW LIGHT ON THE RUINS OF TROY

To the Editor of DISCOVERY

SIR,

The article on above by Mr. Casson in No. 49 is very fascinating and of great interest.

But it leaves me with the impression that Mr. Casson has not explored the possibilities of the geographical conditions so freely as he might have done; and if you agree, perhaps you will persuade him or some other expert to return to this subject in a later issue.

To make my point clear. By aid of your sketch-map—and without local knowledge of the straits—one could deduce the direction of the current from the "narrows" to the mouth. I have indicated my idea of the current in dotted lines in a small tracing of your sketch-map (enclosed herewith).

Now, Mr. Casson says that the current attains a speed of 3 m.p.h. (opposite) Troy; and accepting that speed—at that point or reach—then I think in the narrows the speed would attain 4 m.p.h., or even 5.

Now, in very ancient days, 5, or even 4 m.p.h., in the narrows may have been an impracticable obstacle for rowboats going up the straits, and that obstacle may have led to the practice of breaking bulk in the Sea of Marmora or somewhere above the narrows and of sending the goods overland to a point which subsequently became the city of Troy. When that entrepôt trade was fully established, then would come the time to consider fortifying the mouth of the channel—more especially if, after the lapse of a few centuries, invention and increased skill were beginning to get through the narrow upstream by boats.

Mr. Casson says that boats can enter the straits at all times in slack water, near Cape Helles—and that is what one would expect simply from the land profile. Given that condition, then it would be easy to select a point to cross to and from Troy, so that the current of 3 m.p.h. would aid the crossing in both directions.

Further, I think the Dardanelles is a deep gorge and not an eroded river-bed; and it is possible the gorge persists as a submarine channel some distance south of the mouth and in that way gives some direction to the current on the surface. An Admiralty chart would probably show whether that is so or not.

Yours faithfully,

16 BEXLEY ROAD,
BELVEDERE.
January 9, 1924.

P. W. MASSON.

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